APRIL 1959

Power Engineering

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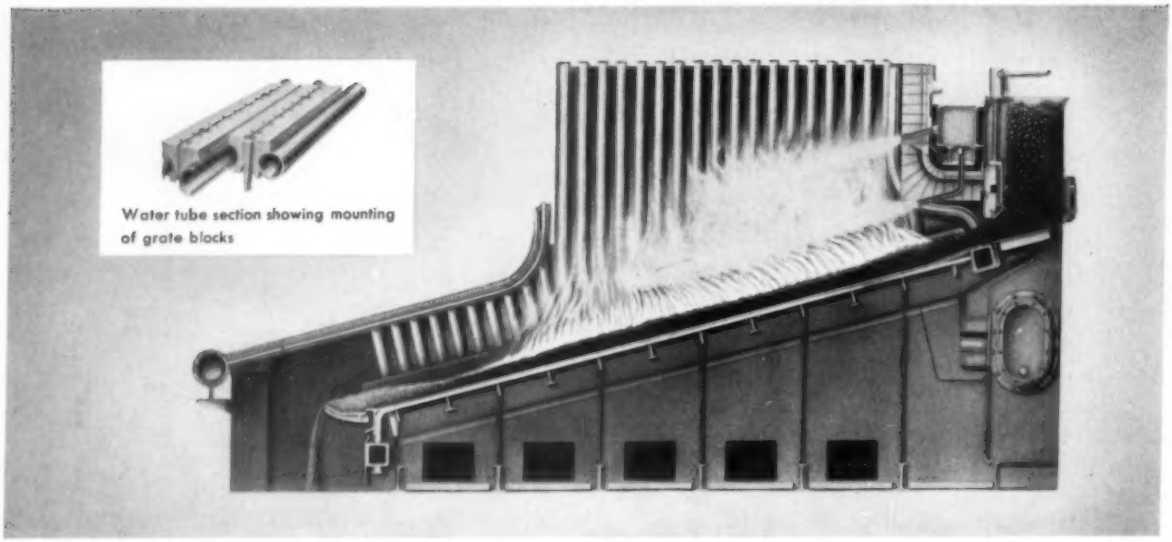

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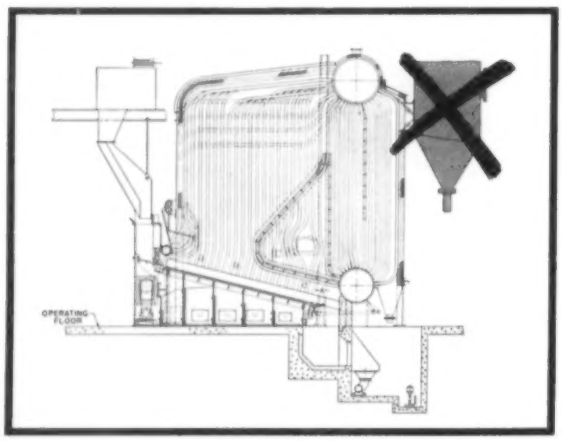

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ENGINEERS' PREVIEW

SALARIES for engineers are going up an average of 6½ per cent a year, and the *median* salary of engineers in industry, government and education in 1958 ranged from $6125 annually for engineers with one year of experience to $11,000 for those with 20 years' experience. This is reported by Engineers Joint Council in a newly published study of professional income of engineers.

This survey is the most comprehensive ever completed in the United States and covers a sample of nearly 200,000 engineering graduates.

In spite of the recession, the 1958 graduates had plentiful job offers and starting salaries were higher than in 1957. Those with a Ph D degree commanded a median starting salary of nearly $10,000 in industry.

Significant in the salary picture is the increase in the past two years for engineers in government, part of which was the flat increase granted by Congress in 1958 for Civil Service engineers. Although salaries of engineers in government increased percentage-wise more than those in industry, this relative rise has not yet placed government employment in a competitive salary position with industrial employment.

Earnings of engineers continued their upward trend, observed in the previous survey interval, 1953–56. The overall median (for all graduates) was $6500 in 1953, $7750 in 1956 (19 per cent increase or about 6.5 per cent annually) and $8750 in 1958 (up 13 per cent from 1956 or 6.5 per cent average yearly). The latter is an increase from mid-1956 to mid-1958.

EDISON MEDAL for 1958 has been awarded posthumously by AIEE to Dr. Charles F. Kettering, "for invention, research and development in the broad fields of industry, engineering, transportation, medicine, education, energy and power resulting in service to all mankind."

AIEE's Alfred Noble Prize Paper Award for 1958 has been given to Dr. Ghaffar Farman-Farmaian of Tehran, Iran. The prize paper dealt with General Analysis and Stability Study of Finite Pulsed Feedback Systems. Dr. Farman-Farmaian is a graduate in electrical engineering from the University of Illinois and the University of California.

George S. Richardson, senior partner of Richardson, Gordon and Associates of Pittsburgh, has been elected president of the American Institute of Consulting Engineers.

I. J. Karassik, well-known expert on centrifugal pumps, has been appointed Consulting Engineer and Manager of Planning for the Worthington Corporation Harrison Division. He has been associated with Worthington since 1934.

PROTEST from General Electric Co is being made over the recent award by TVA of a contract for a 500,000-kw steam turbine generator to a British electrical firm. G-E's bid, lowest of domestic manufacturers, was nearly $5,500,000 higher than that of C. A. Parsons & Co, Ltd, of Newcastle, G. B.

W. S. Ginn, vice president and general manager of G-E's Turbine Division, pointed out that TVA's acceptance of the Parsons bid represents a serious challenge. He noted that the wages of the Parsons firm are less than 60 per cent lower than those paid by domestic electrical manufacturers.

Because of these substantially lower wage rates and competitive facilities, Ginn said, foreign manufacturers can underbid any domestic concern almost at will on nearly every job that comes along.

He further pointed out that price is only one factor that should be considered in awarding contracts for products as vital to the well being of the nation as major electric power producing equipment. Repair of turbine-generator units is also a highly important consideration. Such machines require quick access to the plants in which they were built. When such shops are located abroad, the repair problem can become extremely serious, Ginn stated, requiring extended periods of shutdown.

18TH ANNUAL Science Talent Search for the Westinghouse Science Scholarships and Awards has produced 40 top winners from an Honors Group of 427 high school seniors in towns all across the country. The winners, nine girls and 31 boys, share in $34,250 in scholarship grants provided by the Westinghouse Educational Foundation of Westinghouse Electric Corp. The Science Talent Search is conducted by Science Service through its Science Clubs of America. The Search this year drew a record number of 28,195 requests for aptitude examinations.

MERGER plans have been announced by Rome Cable Corp and Aluminum Co of America. Alcoa will acquire all the properties of Rome Cable for 355,226 shares of Alcoa common stock. This will permit distribution to Rome shareholders of three shares of Alcoa common stock on each five shares of Rome common stock.

Alcoa and Rome plan to combine their electrical conductor, conduit and accessory activities in a new company to be called Rome Cable Co. Present members of Rome's management will continue in their present capacities in the newly formed company.

UP-DATING the Model Smoke Ordinance of ASME is an objective of the Society's Committee on Air Pollution Controls, which has begun the work of reviewing the 1949 model. The new model ordinance will cover not only smoke and ash but also the many other pollutants which are contaminating the air.

ALLIS-CHALMERS' acquisition of S. Morgan Smith Co of York, Pa, has been made final. It will be known as the York Works of Allis-Chalmers. In taking over the Smith facilities, A-C has announced the formation of the hydraulic division of the Industries Group, with headquarters at York.

Beauchamp E. Smith has been named general manager of the hydraulic division. He has served as president of the S. Morgan Smith Co for the past 17 years. Burwell B. Smith will become assistant general manager in charge of sales, and Duncan D. McArthur will be assistant general manager in charge of industrial relations, procurement and the controller's departments. William J. Rheingans, who has been manager of the hydraulic department at the West Allis Works of Allis-Chalmers, will move to York to become assistant general manager in charge of engineering.

MILLION DOLLAR accelerator has been purchased by CalTech under a contract from the Office of Naval Research. The machine is a 10,000,000-electron-volt Tandem Van de Graaff accelerator made by High Voltage Engineering Corp for basic physics research. Fourth machine of its kind in the world, it will be installed at CalTech's Kellogg Radiation Lab.

E. W. BISSON of G-E and L. H. Horn of the Underwriters' Laboratories report that several million "hot chassis", direct-connected television receivers with metal cabinets are presently in use in American homes. With a failure of insulation or spacing in these receivers, they point out in an AIEE paper, a serious shock hazard condition can result.

Bisson and Horn state that two methods appear attractive in reducing this hazard. The more obvious way is to employ a three-conductor supply cord and a three-blade attachment plug cap with the grounding conductor of the cord and the grounding blade of the cap connected to the cabinet.

The second method is to make use of the polarity provision built into modern 120-volt two-blade outlet receptacles and connect the chassis of the receiver to that conductor of the supply cord which connects to the blade of the cap corresponding to the grounded or neutral side of the power supply circuit.

With the polarized method, which calls for a "floating" or non-grounded cabinet at all times, failure can be expected to be minimized. Two failures are required to produce a hazardous condition. Exposed conductive parts can become live to earth ground only if the cord, cap, or supply circuit polarity is reversed and the insulation and spacings incorporated in the receiver between line-connected parts and exposed conductive parts fail.

MEETINGS AHEAD: 40th annual convention and Welding Show of the American Welding Society will be held the week of April 6 at the Hotel Sherman and the International Amphitheatre in Chicago.

Fourth Biennial Conference on Electric Heating, sponsored by AIEE, will be held April 14-15 in the Bellevue-Stratford Hotel, Philadelphia.

Annual Conference of the Maintenance and Plant Engineering Division of ASME will be held May 4 and 5 at the Edgewater Beach Hotel in Chicago. The American Institute of Plant Engineers will participate as co-sponsor.

Technical sessions on the first day of the conference will feature the presentation of five papers. A noon luncheon will be presided over by S. A. Simonson, president of AIPE. Speaker at the evening banquet will be Glenn Warren, president of ASME.

During the morning of the second day a forum will be held, with five nationally prominent panelists discussing various aspects of maintenance, and answering questions submitted by the audience. There will be a trip to the new $100,000,000-plus Chicago filtration plant, now nearing completion.

GRANT of $57,600 from the National Science Foundation will enable three University of Wisconsin engineers to launch a continued study of the process by which liquid fuels mix with air and become combustible in the combustion chambers of motors and engines. The three engineers who will make the study are Profs. Phillip S. Myers, Otto A. Uyehara, and M. M. El-Wakil.

In the study, liquid fuels under investigation will be sprayed, and their behavior under conditions simulating various types of combustion chambers will be photographed and the vaporization analyzed.

Ever-increasing requirements for speed and power in propulsion have created a greater need for the development of a scientific basis for the design of these chambers.

Ultimate goal of the study, according to Prof. Myers, is formulation of an overall theory of the atomization and vaporization of liquid fuels in continuous-flow heterogeneous combustion systems.

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WHAT THEY TELL US

▶ **LATEST** issue of the Navy's Budocks *Technical Digest* reprints POWER ENGINEERING'S article (July, 1958) on How the Navy Engineers Its Utilities Conservation Program, written by Cdr J. G. Dillon. Comments Carl M. Mann, *Digest* editor:

> Although POWER ENGINEERING has many devoted readers throughout the Shore Establishment, we felt that by reprinting Cdr Dillon's article, we could make his good advice available to all working levels.
>
> Your publication has done a fine service, indeed, in bringing this Bureau's sincere efforts in engineering to the attention of professionals in industry who share kindred problems.

▶ **START-UP** responsibilities for a new steam generating plant in Spencer, Iowa, have fallen to the lot of Dan C. Adams, chief engineer of the Corn Belt Power Cooperative. Adams tells us that:

> In anticipation of that, I have been reviewing the last two years' issues of POWER ENGINEERING for the articles you have printed regarding the start-up of new plants. I have been particularly interested in those by Paul N. Garay and J. H. Hunnicutt on that subject. Would it be possible that you still have reprints on this subject available? If so, I would appreciate your sending me anything you have.

Reprints of Your New Industrial Power Plant — How to Get It Into Operation, by Paul N. Garay, and Jeff Hunnicutt's series, Effective Start-Up Engineer Smooths Out Preliminary Power Plant Operation, are still available to help those faced with a start-up procedure.

▶ **TRAINING** development in Britain, of interest to the power field, comes to light in correspondence we've had with J. W. Graely, education and training officer for the Central Electricity Generating Board in London. Graely tells us that:

> Arrangements are being made for a correspondence course on Modern Power Station Practice to be produced, and in this connection many of our senior engineers and administrative officers are writing lessons on subjects of general interest to the technical staff employed in the electricity supply industry. . . . The course will be taken by engineers employed by the Generating Board and all printing and administrative arrangements for the course will be undertaken within our organization.
>
> The copyright of the lessons will be vested with the Board, although no attempt will be made to reproduce the lessons for external circulation, except in cases where special requests for copies of the lessons are received from overseas electricity corporations.

▶ **E. R. MOORE,** manager of engineering for Detroit Edison, who wrote the section on generation and transmission in our January review of what's ahead in the power engineering field, comments:

> In writing the article for the January issue of POWER ENGINEERING, I did not appreciate the fact that it would become a part of a very excellent presentation intended to bolster interest on the part of engineering students to prepare for and enter the power field. I am very glad to have a part in this project.

Another of the experts who contributed to the review in January was Sabin Crocker, who writes:

> I wish to express my appreciation for the way you have presented my contribution on Developments in Power Piping, and for being included among so distinguished a group of authors.

▶ **HP FROM DOG POWER** piece in our January issue (page 69) has stimulated memories in reader John H. D. Blanke of Barrington, Ill.:

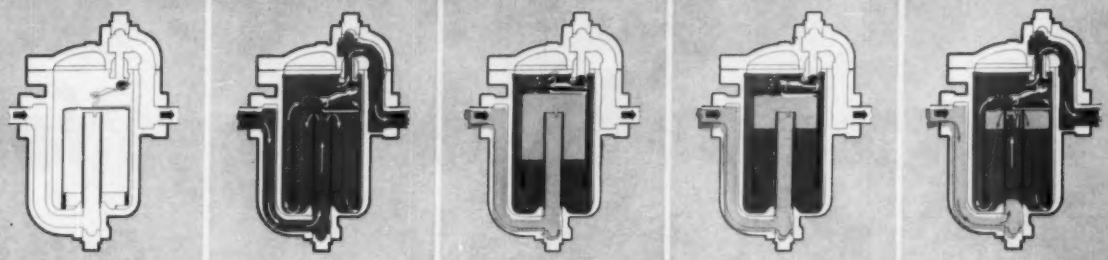
> Your interesting item, Would It Work?, brought my memory back to the turn of the century. Maybe the 1859 invention showing how to get horse power from dog power did not work out in practice. But I can verify the existence of a dog power machine that did work; at least it turned out rich golden butter and left genuine buttermilk such as cannot be had today.
>
> On my family's farm in northwest Germany, years ago, we had a large treadle wheel mounted in a fence enclosure provided with a side gate. The wheel, some 10 ft in diameter, if my memory serves me right, turned a smaller cog wheel that moved a walking beam up and down, thus moving the disc in the butter churn up and down.
>
> The dog trained for the job did fairly well, but he needed some encouragement now and then. The best way to get him walking was to hang some liver sausage on the fence. Aspiring to reach it, he kept turning the wheel and made the butter.

▶ **PLAN** for a catalog service for engineering offices, which would assure that manufacturers' literature would be well received and always available in the engineering office, is being proposed by reader J. W. Hollis, Jr, of Laurinburg, N. C. Hollis would like to hear from other readers in reaction to the plan. Background of the idea, as Hollis explains it:

> The problem is that the average engineer does not adequately maintain his catalog file. True, he does not throw anything away, but when he needs some data in a hurry, he hardly knows where to look for it.
>
> In order to change this situation and make sure he has the catalog on hand, up-to-date and ready for reference, I am proposing to offer this service:
>
> To have under direct supervision in each city or town where an engineering office is located, employees (either full or part time) who would once a month visit each engineering office and deliver and file the manufacturer's literature. I believe that if a sufficient number of manufacturers joined the plan that this could be done for about 50 cents per month per engineer per manufacturer.
>
> All the literature issued by the subscribing manufacturers would be sent to our headquarters where it would be sorted for distribution according to the manufacturer's list, and forwarded in one package containing all the items to go to each engineer for the month. On a prescribed schedule, the local employee would take this material in turn to each engineering office, file it properly and remove old material. This service would relieve the engineer of the necessity for maintaining the catalog.
>
> As to who needs this service: I think that most engineers have a few favorite catalogs and the others get very little consideration except in the larger offices where there is a staff librarian. I am contending that a manufacturer, especially a new one, would have a better chance, once he had the attention of a prospect, if his literature were complete enough for plans and specifications to be prepared directly from the literature on hand.

There are plenty of pros and cons to this proposal by Hollis.
Let's hear your opinion.

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

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3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* – Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* – Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* – Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

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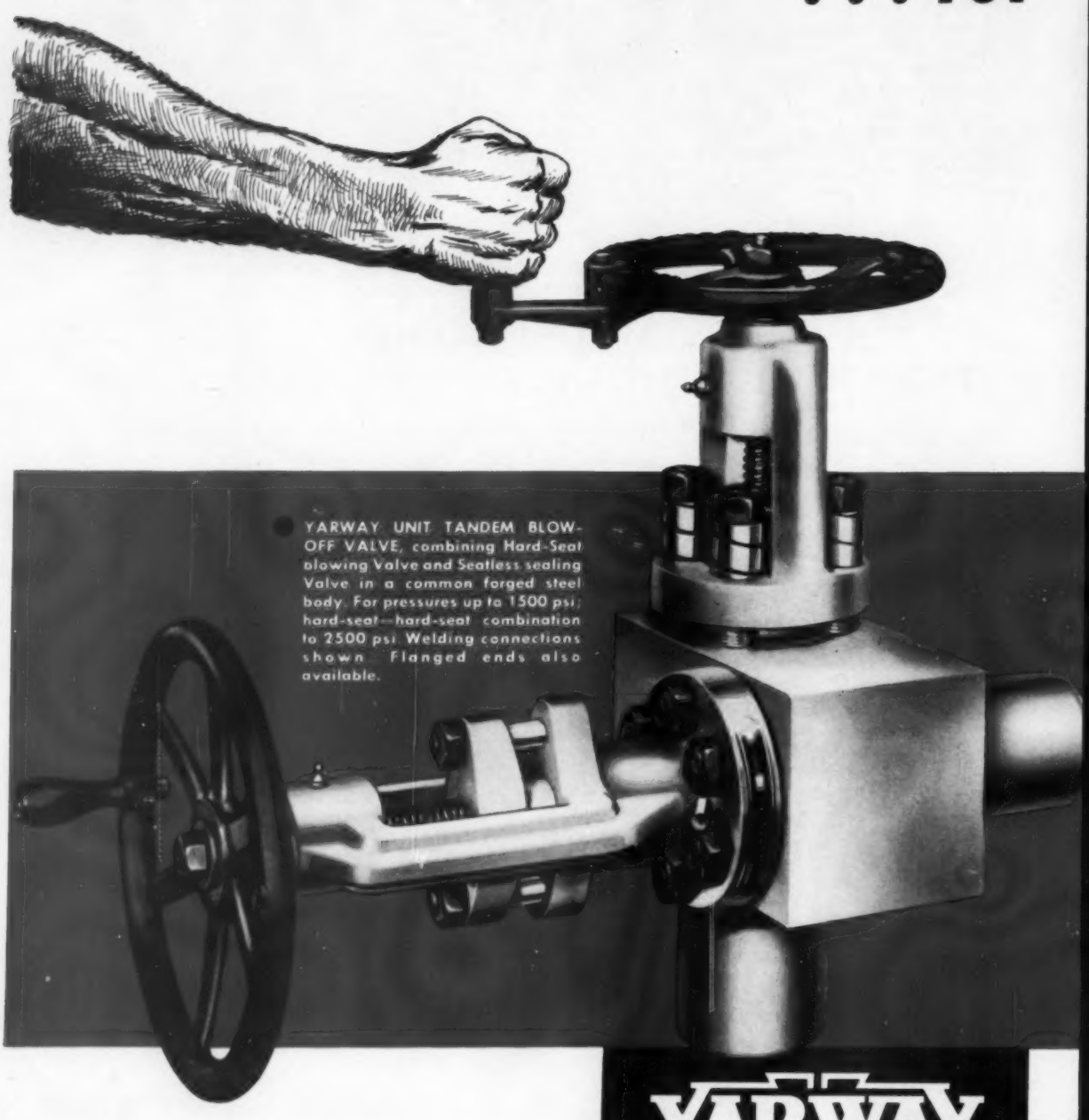

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More than 80% of high pressure boiler plants are equipped with YARWAY *Blow-Off Valves,* and there's ample reason.

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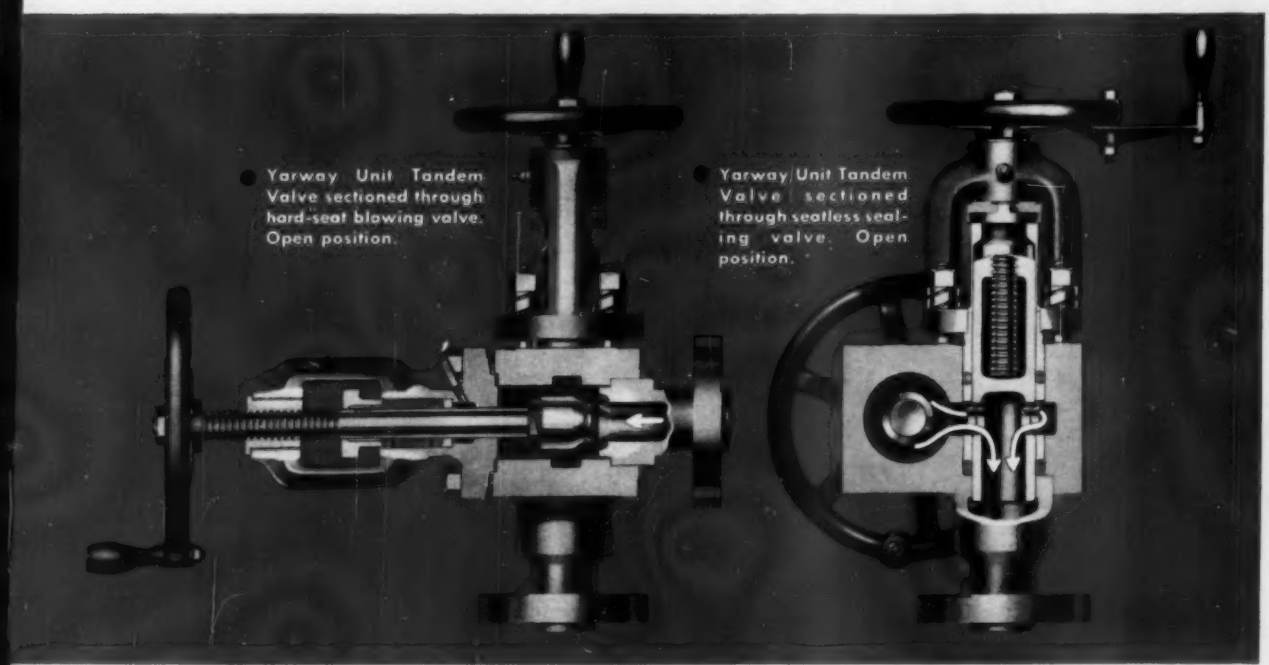
100 Mermaid Ave., Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES



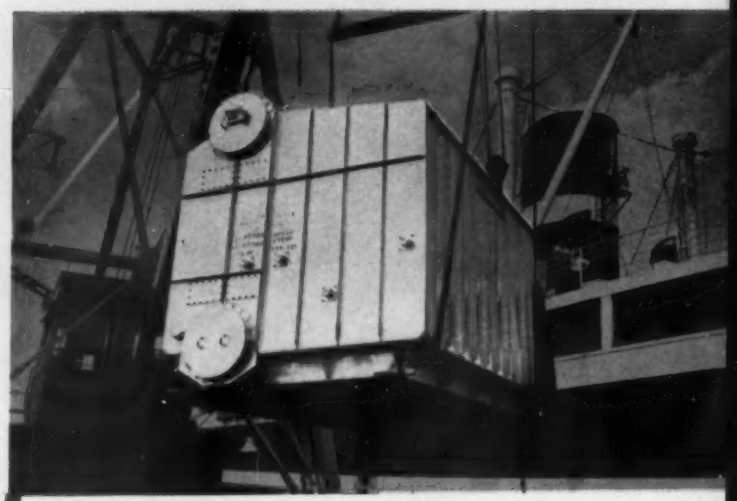
Yarway Unit Tandem Valve sectioned through hard-seat blowing valve. Open position.

Yarway Unit Tandem Valve sectioned through seatless sealing valve. Open position.

— blow-off valves

For more data circle 506 on Post Card

A C-E Package Boiler, Type VP, en route to Europe. This boiler type is available with capacities from 4,000 to 90,000 lb of steam per hr, with pressures to 700 psi and temperatures to 750 F in certain sizes. It is designed for oil or gas firing. Several hundred of these units are now in service.



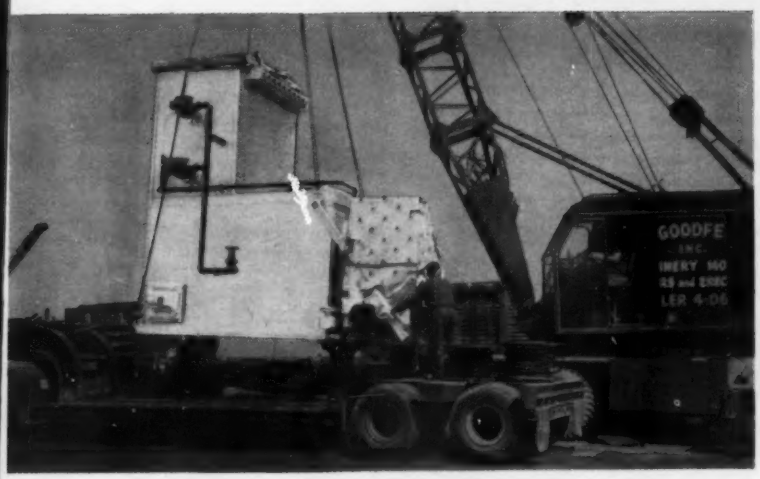
NOW C-E offers LARGER SHOP-ASSEMBLED BOILERS

Three service-proved designs with capacities to 120,000 lb

The economies inherent in shop-assembled boilers can now be yours even if your steam requirements are as high as 120,000 lb per hr. The C-E line, consisting of three basic unit types, has been expanded to include pressures, temperatures and capacities well beyond normal package-type limits.

The standard, natural-circulation, ***C-E Package Boiler—Type VP***—is now available with capacities to 90,000 lb per hr, and with pressures and temperatures to 700 psi and 750 F. Where greater steaming capacity is required, or where higher pressures or temperatures are needed for industrial processing or power generation, the shop-

A shop-assembled Controlled Circulation Boiler, Type PCC, being prepared for shipment. This type unit is available with steam capacities from 80,000 to 120,000 lb per hr, and with pressures and temperatures to 1000 psi and 900 F. For special applications, designs are available to provide higher steam pressures and temperatures. Seven PCC Boilers are now in service.



A shop-assembled C-E High-Temperature Water Boiler, Type HCC, being unloaded at a midwest manufacturing plant. It is one of two 12-million-Btu boilers used for plant heating. Available for capacities from 10 million to 300 million Btu, this unit type is shop-assembled in sizes up to 50 million Btu for oil or gas firing — up to 40 million Btu for coal firing. Currently, more than 50 HCC Boilers are in service or on order.

per hr...pressures to 1000 psi...temperatures to 900 F

assembled ***C-E Controlled Circulation Boiler — Type PCC*** — is available. It is designed for the 80,000-to-120,000-lb capacity range, with pressures to 1000 psi and temperatures to 900 F. For special applications, this unit is also available for considerably higher pressures and temperatures.

The C-E High-Temperature Water Boiler — Type HCC—is an ideal type for large space-heating and certain process uses. It is also available in shop-assembled form for capacities to 50 million Btu per hr. It is designed for pressures to about 500 psi, and can provide water at 450 F or higher.

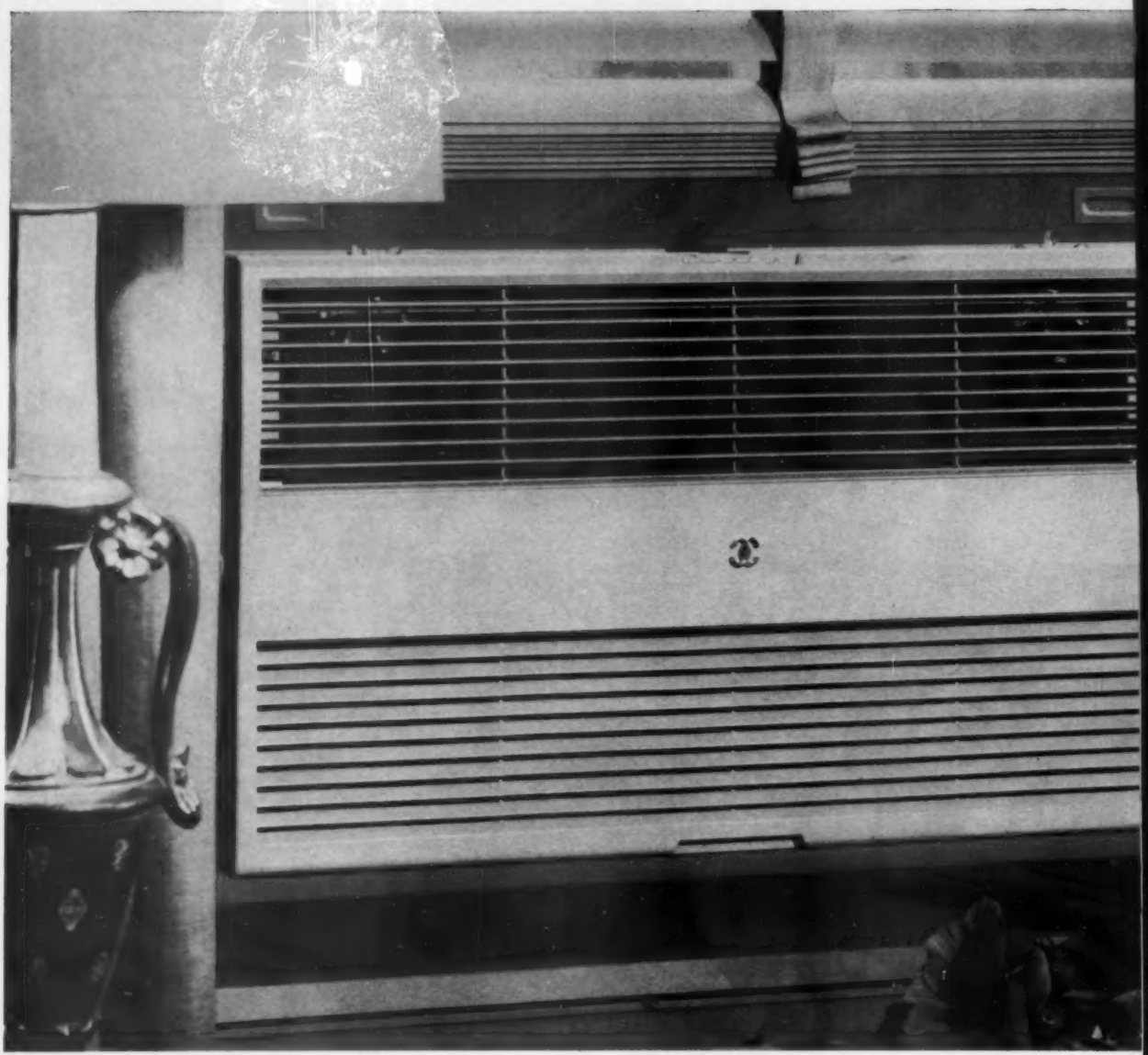
The new, high-capacity ranges of these shop-assembled units represent the logical evolution of familiar and successful designs that have been proved in service for quality, economy and performance.

Catalogs on any or all of these units available on request.

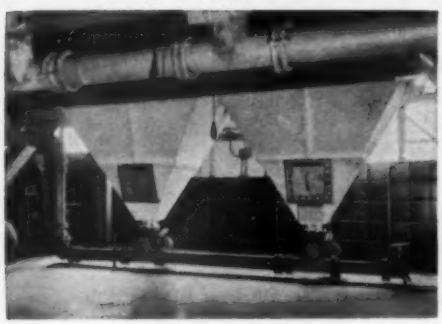
COMBUSTION ENGINEERING

C-E

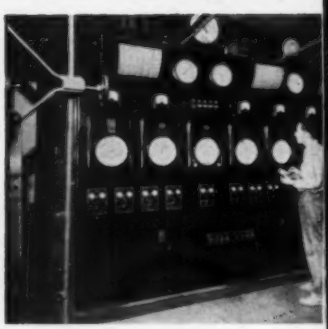
C-202



General view of Carrier power plant. Boilers on right are bent tube, two-drum types, by Riley Stoker Corp. burning pulverized coal. Coal moves from bunkers to Riley Pulverizers (at left in photo) and then into furnace.



Mechanical dust collectors by Prat-Daniel Corp. help assure cleanliness of operation. These collectors tie in with United Conveyor ash handling system for movement to ash silo and final disposal.



Pneumatic automatic control panel by Bailey Meter Co. regulates combustion operation of all boilers and auxiliary equipment, maintains continuing steam generation efficiency!

Carrier puts the chill on fuel costs...with coal

Air conditioner manufacturer uses coal for low-cost steam

An unusual team—the heating ability of coal and the cooling facility of air conditioning equipment! Yet Carrier Corporation, Syracuse, N.Y., found this combination profitable when expansion plans required additional capacity in its steam plant. After engineering surveys, Carrier decided to continue burning coal for economy of operation. Today modern power equipment supplies steam *economically* for heating, air conditioning and processing. Original fuel costs plus automatic operation within the power plant hold overall steam costs to a minimum.

Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for our case history booklet, complete with data sheets. You'll find them informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

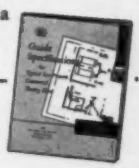
BITUMINOUS COAL INSTITUTE

Dept. PE-04, Southern Building, Washington 5, D. C.

See our listing in *SWEET'S*

Coal is loaded into silos before it moves to bunkers. At left is the ash silo which utilizes rotary dustless unloader in loading trucks for disposal. Silos and conveyors are by Fairfield Engineering Co.

SEND COUPON FOR NEW BCI PUBLICATIONS. Guide Specifications, with complete equipment criteria and boiler room plans:



BITUMINOUS COAL INSTITUTE,
Southern Building, Washington 5, D. C.

Gentlemen: Please send me: **PE-04**

☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker); ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker); ☐ GS-3 (automatic package boiler for heating and process plants). ☐ Case histories on larger plants.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

For more data circle 508 on Post Card

NEW EDWARD IMPACTOGEAR

What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

How Impactogear* operates high-pressure valves

You no longer need a crew of men to open or close big, high-pressure valves. New Edward Rockwell-built Impactogear makes big-valve operation a quick and easy job.

FAST AND EASY "RUNDOWN"

Your operator simply applies portable air or electric wrench to pinion shaft-end of Impactogear. When power is applied, pinion turns ring gear, which turns handwheel and moves the stem to "closed" position. Impactor* handwheel then gives final tight shut-off with unique "hammer-blow" action. (Tests show it delivers 12 times the closing force of ordinary handwheels—with less effort!) Impactogear works quickly, can operate a 2500-lb 10" valve (for example) in only 2½ minutes. And Impactogear can be fitted to any 8" or larger Edward valve of 900-lb (or higher) pressure class.

IMPACTOGEAR WITH AIR WRENCH

Impactogear utilizes standard portable air or electric wrenches generally available throughout industry. Example below shows how two typical air wrench ratings can be applied:

Wrench Type No. 1—Stall torque 170 ft-lbs: Free speed 225 rpm; Weight 12 lbs

For 12" and 14" 2500 lb. valves, operating pressures to 3500 psi

For 10" 2500 lb valves, all allowable operating pressures

For 10", 12" and 14" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

Wrench Type No. 2—Stall torque 200 ft-lbs: Free speed 300 rpm; Weight 38 lbs

For 12" and 14" 2500 lb valves, operating pressures 3500 psi to 4500 psi

IMPACTOGEAR WITH ELECTRIC WRENCH

Portable electric wrenches are equally practical. Example below shows a typical electric wrench rating as applied to Impactogear:

Wrench Type No. 1—Stall torque 176 ft-lbs: Free speed 225 rpm; Weight 44 lbs

For 10" 2500 lb valves, all allowable operating pressures

For 10" and 12" 1500 lb valves, all allowable operating pressures

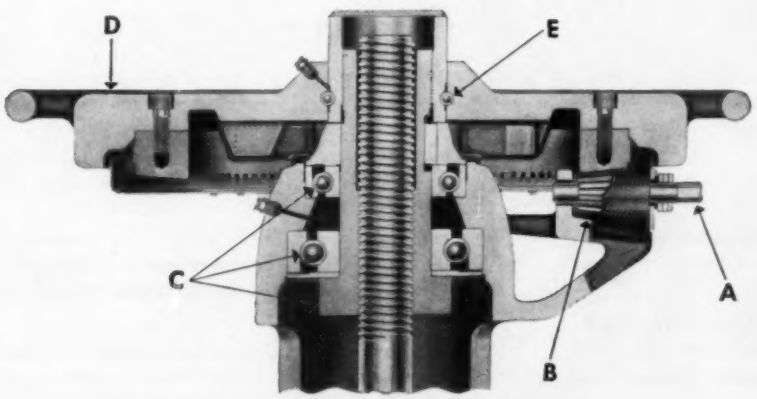
For 12" and 14" 900 lb valves, all allowable operating pressures

SLASH COST OF VALVE OPERATION

Individually installed operating motors are a big investment. They can add as much as 100% to the basic valve cost. *But now you can save that money by standardizing on Impactogear*—radically simple, thoroughly dependable mechanism utilizing *existing* compressed air or electric facilities. Your Edward Representative will be glad to provide full details and help you determine how Impactogear can work to your best advantage. Contact him—or write *Edward Valves, Inc., 1202 W. 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

LIGHTWEIGHT PORTABLE WRENCH can operate as many Impactogear-equipped valves as desired. Or, each valve can be fitted with its own wrench. Either way, you get lower operating costs. Final closing is effected by handwheel lugs (A) striking hammer blows against cross arm keyed to yoke bushing (B). Half of gear cover was removed for illustration purposes.

*T.M. Reg. U.S. Pat. Off.



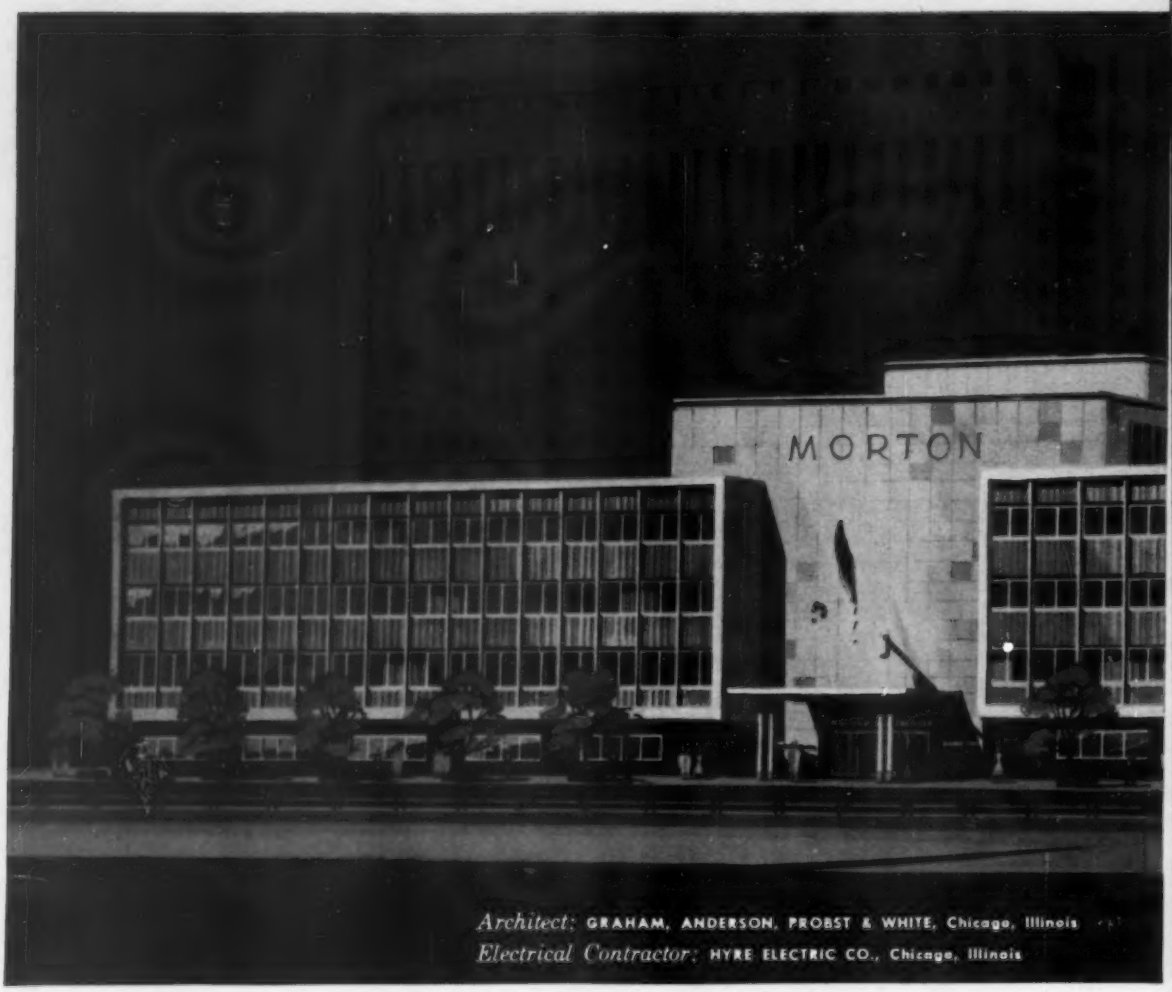
Details of new Impactogear and Impactor Handwheel:

A—Hex head of pinion gear shaft. Power wrench is applied here. B—12-to-1 bevel gear ratio is typical for median size handwheel. C—Exclusive EVAlthrust yoke bushing combines radial and thrust bearings for easy operation and long life. D—New Impactor handwheel concentrates mass near outer circumference for maximum impacting efficiency. E—New extra bearing increases operating efficiency.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs: with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

For more data circle 509 on Post Card



Architect: GRAHAM, ANDERSON, PROBST & WHITE, Chicago, Illinois
Electrical Contractor: HYRE ELECTRIC CO., Chicago, Illinois

Electrical Protection goes MODERN *with BUSS fuses! . . . in the MORTON SALT BUILDING Chicago, Ill.*

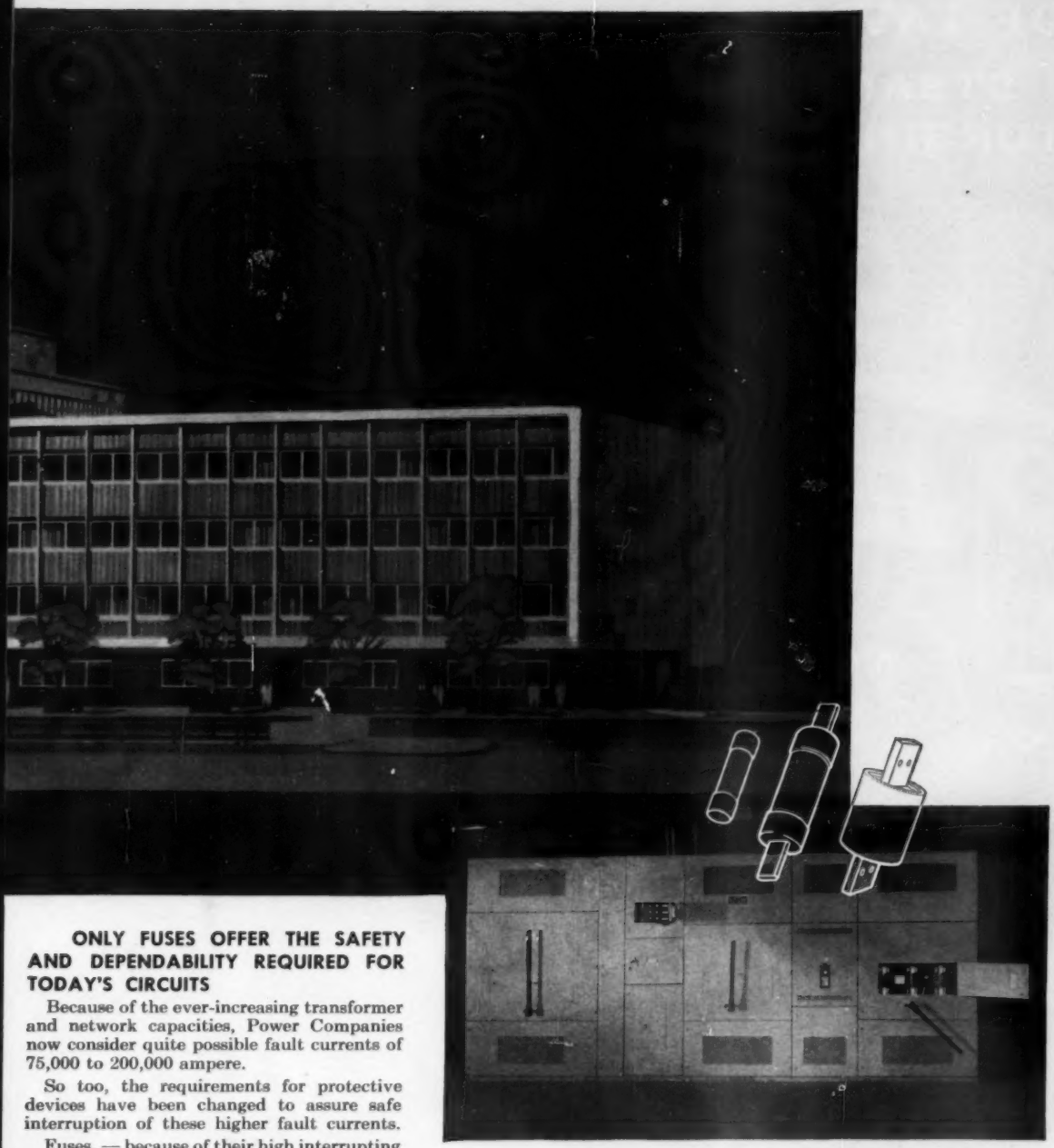
The beautiful, new Morton Salt Building is located at 110 North Wacker Drive in Chicago — just outside the Loop.

The safest and most dependable electrical protection was needed because the engineers estimated the available fault current might easily reach a value of 75,000 amperes.

For this reason, the main switchgear, consisting of 1-4000 ampere, 1-2000 ampere and 1-1200 ampere pressure switch, is completely equipped with BUSS Hi-Cap fuses.

To make available the same safe, dependable and trouble-free protection, all distribution panels are equipped with FUSETRON dual-element fuses.

THERE IS A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED



ONLY FUSES OFFER THE SAFETY AND DEPENDABILITY REQUIRED FOR TODAY'S CIRCUITS

Because of the ever-increasing transformer and network capacities, Power Companies now consider quite possible fault currents of 75,000 to 200,000 ampere.

So too, the requirements for protective devices have been changed to assure safe interruption of these higher fault currents.

Fuses, — because of their high interrupting capacity and dependability — prove superior in meeting modern protection requirements.

With Fuses, Safe Protection Remains Safe

Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time. The operation of a fuse is not dependent on latches, triggers or other devices that are subject to the strains and jars of mechanical action — both in opening and closing.

A fuse cannot stick or fail to operate when electrical trouble occurs. 1 year, 5 years or 20 years from now, a fuse will provide the same, high degree of protection as on the day it was installed.

Morton Salt Building: Mains and Feeders protected by BUSS Hi-Cap and FUSETRON Fuses

On installations of 0 to 600 amperes . . .

By Installing FUSETRON dual-element FUSES—YOU GET 10 POINT PROTECTION

With rare exceptions, other types of protective devices protect only against short-circuits —

BUT, FUSETRON dual-element fuses give you safe, trouble-free 10 point protection.

For the FUSETRON fuse story ask for Bulletin FIS.

For Loads above 600 amperes . . .

BUSS Hi-Cap Fuses offer Safest, Most Modern Protection

They have an interrupting capacity sufficient to handle any fault current regardless of system growth — and by coordinating them with FUSETRON fuses on feeder and branch circuits, outages caused by fault currents can be limited to circuit of origin.

For the BUSS Hi-Cap fuse story ask for Bulletin HCS.

BUSSMANN MFG. DIV. McGRAW-EDISON CO. ST. LOUIS 7, MO.

For more data circle 510 on Post Card

DE LAVAL STEAM TURBINES

for process industries

The photograph above shows a De Laval direct-connected turbine generator installation at Parke, Davis & Co., Detroit, Michigan.

This controlled extraction, controlled back-pressure unit supplies 5000 kw using process steam. Extraction is at 130 psig, exhaust is 5 psig. This new machine was added to already existing De Laval units that have been in service for 30 years. In addition, the Parke-Davis Research Laboratories in Ann Arbor, Michigan will soon be using a new 1000 kw unit.

DL-449

Parke, Davis & Co. uses DE LAVAL Steam Turbines for process and power generation

Proved economy, dependable service

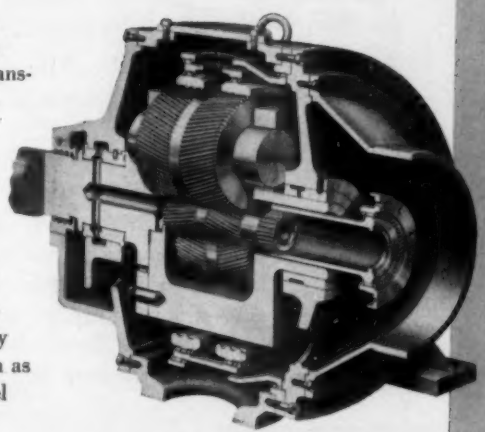
In many process industries, an important by-product is economical electric power. If appreciable quantities of process steam are used, power generation can be achieved at comparatively low cost.

De Laval, pioneer in high speed rotating machinery, has continued to maintain engineering and manufacturing leadership. If you have process application where low-cost power generation can be utilized, call on De Laval.

De Laval-Stoeckicht Planetary Gears

In many applications where high speed and high horsepower are transmitted, the De Laval-Stoeckicht planetary gear can be used to great advantage. It is also used as a speed increaser or decreaser in many industrial installations.

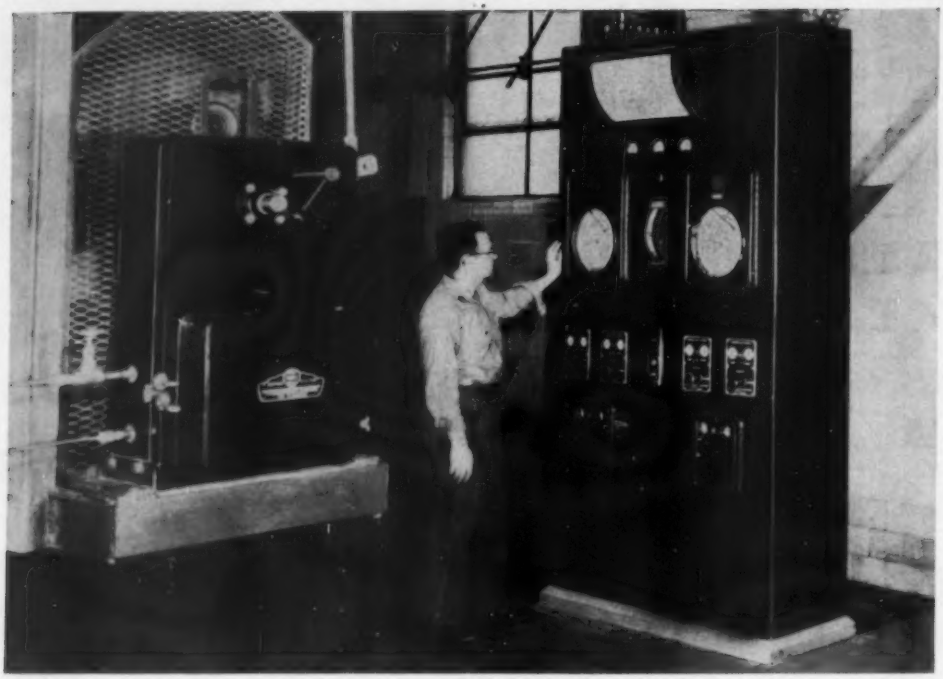
Among its outstanding characteristics are light weight, in-line construction and space saving. It may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc.



Write for Bulletin 2400

DE LAVAL *Steam Turbine Company*

816 NOTTINGHAM WAY, TRENTON 2, N. J.



This Bailey Control System helps cut fuel costs on a 70,000 lb per hr capacity 125 psi boiler in an industrial plant. Control drive in foreground regulates stoker.

How Bailey stretches your fuel dollar...

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering control on your steam plant control problems.

A132-1

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more data circle 512 on Post Card

water treatment "weak links" can be boosting your operating costs

There are five important links in the ideal water treatment chain . . . five basic requirements for trouble-free water conditioning.

If any one is missing or functioning improperly, the entire steam-water cycle is affected leading to operating problems, efficiency losses and, sooner than necessary, costly downtime and repairs.

Dearborn engineers will survey your complete system from raw water to condensate return . . . uncover potential weak links . . . collect data for a precision water treatment program scientifically developed to meet your exact needs.

Such programs provide for continuing positive control . . . often result in substantial savings.

Write for Bulletin which tells why and gives details of Dearborn's unique Water Treatment Consulting Service.

DEARBORN CHEMICAL COMPANY

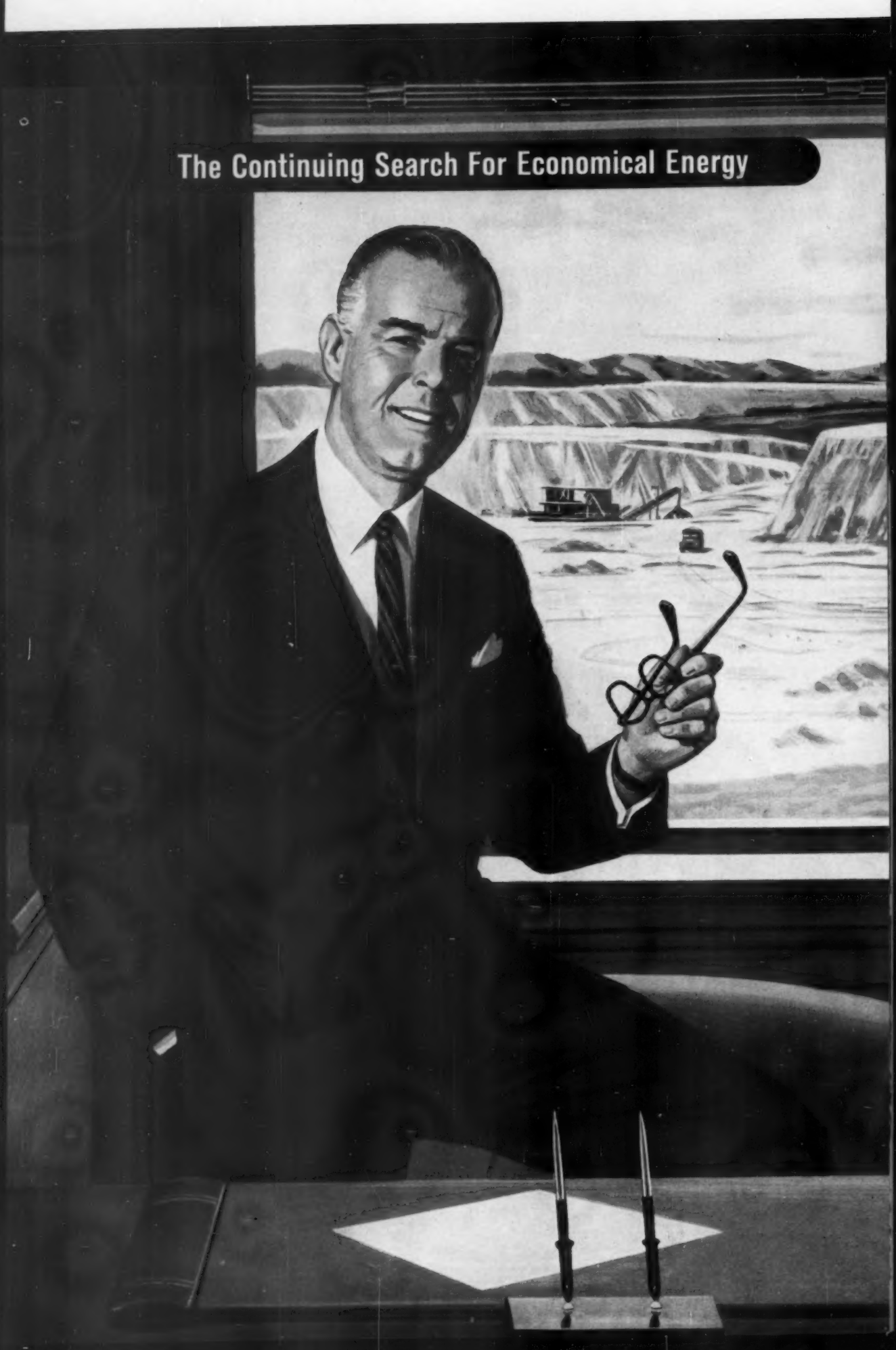
Executive Offices: Merchandise Mart, Chicago 54 • Plants and Laboratories: Chicago • Linden, N. J. • Los Angeles • Toronto • Havana • Buenos Aires

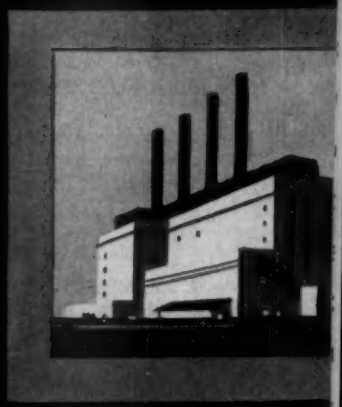
pioneer in the science of corrosion control

dearborn

For more data circle 513 on Post Card

The Continuing Search For Economical Energy





Do you have a coal mine in your back yard you can't use?

In areas like Florida and the Southwest, where the use of coal has been traditionally prohibitive, utilities are now considering it as an economical, easily available fuel. Why? How is it possible? The answer is B&W research in coal and coal-burning equipment.

At B&W's Research Center, testing of over 33,000 coal samples has provided some important cost-cutting answers—answers that will help you hold the line on operating costs. Important answers that permit building equipment around the fuel you can most inexpensively burn.

What's more, B&W recommendations are completely objective. B&W designs and manufactures all types of fuel burning equipment—for every fuel burning application.

For example, the most economical and satisfactory way to burn lower-grade, high-ash, low-fusion coal, is in the B&W Cyclone Furnace. Less space, fewer burners, more complete fuel consumption, and elimination of fly ash problems are just a few of its many advantages.

We will be glad to discuss your fuel burning problems with you, and to make recommendations based on your special requirements. Write to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

G-908-C5

Reliance Boiler Safety for 75 Years

There has always been danger from low water in boilers — even at 50 lbs. pressure! Accidents — *boiler explosions* — did happen back in the days when pressures over 50 psi were considered "high".

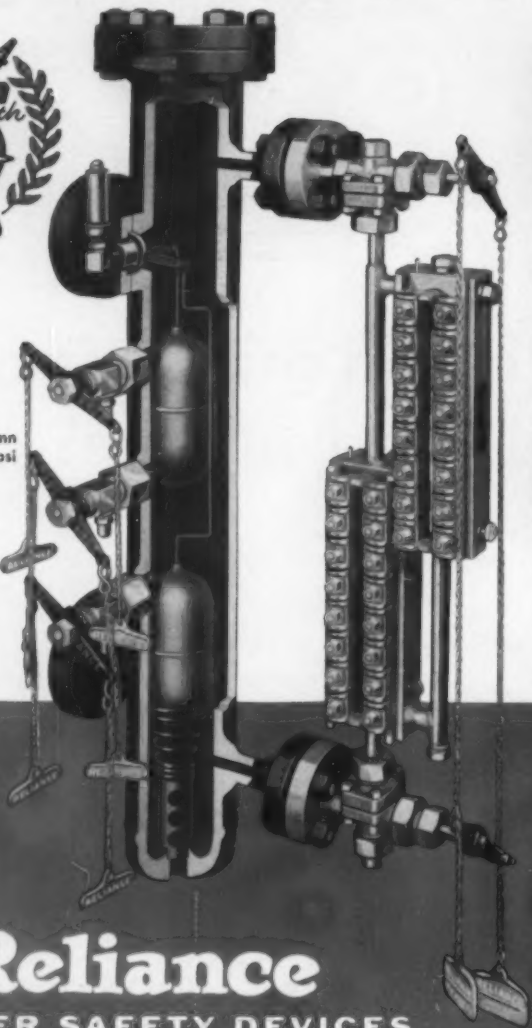
So the Alarm Water Column was invented by a man who recognized the need, and in 1884 Reliance introduced the forerunner of water columns used today in thousands of power plants.

Reliance has kept abreast of the steady rise in working steam pressures with appropriate designs in water columns, with and without alarms. Necessary items for column "trim" — try cocks, gage valves and gage inserts, (also direct-to-drum assemblies) gage illumination, and auxiliary alarms and indicators are offered in various types to suit all needs.

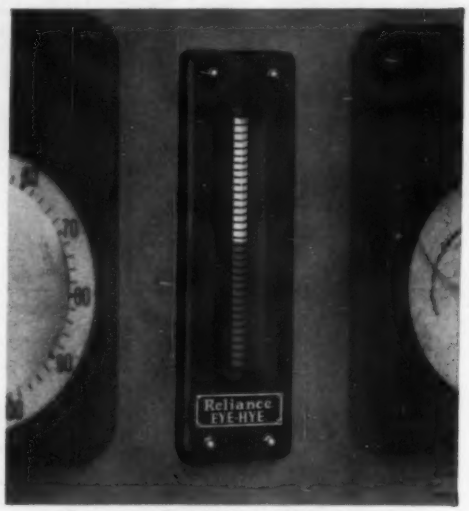
Reliance produced the first compensated remote reading boiler gage in America. The EYE-HYE now serves as an extra safety factor for many thousands of boilers, both stationary and marine. More recently, Reliance electrode-type devices have made it possible to actuate alarms, fuel cutouts, and start and stop pumps on any pressure.

The *originator* of safety water columns, Reliance has been the only manufacturer devoted exclusively to the measurement of boiler water levels for the past 75 years . . . Reliance engineer representatives are located in all principal cities.

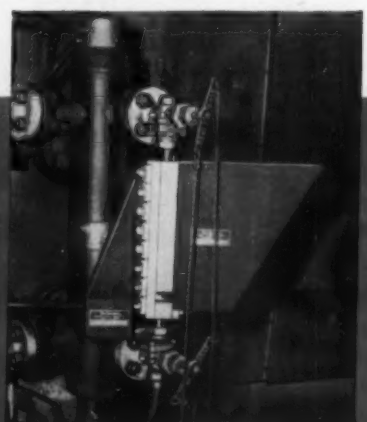
1884 75th YEAR 1959



Typical Water Column for pressures to 900 psi



Above — newly styled EYE-HYE remote gage readable up to 90° either side of center.



Reliance
BOILER SAFETY DEVICES
The Reliance Gauge Column Company, Cleveland 2, Ohio

For more data circle 515 on Post Card

HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 119 and 120.

BOILERS, GENERATORS

101 Generators, Auxiliaries — Twenty-pp Catalog SB 60, on steam generators and allied equipment, provides cross section views of major products to show design and construction. Standard and special boilers are included, also burners, stokers. Erie City Iron Works.

102 Vapor Drum Boilers — Sixteen-pp Bulletin 491 shows recent industrial installations featuring the drum modulatic water tube boiler. The story of each installation is told in photos and captions showing how heating problems were solved by single and multiple boilers, both low and high pressure systems. Vapor Heating Corp.

103 Steam Atomization — Bulletin 1252 describes a packaged firetube boiler with steam atomization designed for burning low-cost heavy oils. Advantages and operation of the atomizing burner are detailed, and a cutaway showing features of the steam/air atomizing nozzle is included. Orr & Sembower, Inc.

PUMPS

104 General Purpose Pumps — Described in 18-pp Bulletin B-1300 are horizontal centrifugal pumps capable of handling water and other non-abrasive liquids in quantities up to 70,000 gpm. Cutaway sectional views and cross-section drawings illustrate details of design and construction. Tables of dimensional and performance data are included. Peerless Pump Div., Food Machinery and Chemical Corp.

105 Rotary Pumps — Bulletin 1536 covers general-purpose, industrial, internal gear rotary pumps. Describes operation and construction, applications, and includes capacities, rpm tables, dimension table with diagrams. The Deming Co.

106 Controlled Volume Pumps — Bulletin 1257 describes company's mini-Pumps for metering chemicals in minute volumes against pressures. Contains complete specifications on laboratory, industrial and chromatographic designs. Milton Roy Co.

107 Fire Pump — Featured in Bulletin 08B9032 and 08B8551s are fire and low pressure pumps which can be driven by motor, gas or diesel engines or steam turbine and available as a package including pump, motor and manual or automatic control. Pump specifications, fitting arrangements, hose header locations, nozzel dimensions, and selection chart and performance curves are included. Allis-Chalmers Mfg. Co.

SEALS

108 Circulating Seal — Described in illustrated Catalog 487 is a circulating seal designed to reduce temperature of liquid in stuffing box. Cutaway view and diagram illustrate design and construction features of the circulating ring which provides circulation of liquids to maintain temperatures. Durametallic Corp.

109 O-Ring Data — Design and application of "O" rings for dynamic sealing and static gasketing is the subject of 20-pp Bulletin AD-148. Discusses materials of construction, dynamic and static applications, use of back-up or non-extrusion rings, and groove design for this style of packing. Dimensional data tables are included, as well as drawings, diagrams. The Garlock Packing Co.

ELECTRICAL

110 On Motor Selection — Bulletin B-2103-4 gives concise selection data for users of a-c motors from 1 through 200 hp. Includes explanations of design classes, speed-frequency relationship, current and torque valves, as well as frame selection tables and complete dimension information and mechanical modifications for all frame sizes from 182 through 6085. Reliance Electric and Engineering Co.

111 Motor Application Guide — Sixteen-pp Form 270-A describes nine major factors in motor selection. Includes polyphase, single phase and d-c motor selection charts which describe typical motor driven equipment, show starting and running torques, load characteristics, type of motor to use, starting currents, speeds, capacity, available enclosures, performance data and mounting specifications. Century Electric Co.

112 Single-Phase Motors — Bulletin 470-B describes integral horsepower single-phase motors, ¾ to 20 hp, in open protected, totally enclosed fan-cooled and explosion proof frames. Bulletin outlines company's "weatherizing" treatment which makes motors suitable for use in damp, dirty or corrosive atmospheres. Tabulated ratings, dimensions included. Motor Div., Robbins & Myers, Inc.

113 Fhp Motors — Twelve-pp Bulletin S-1 lists and describes reducer and nonreducer motors of various types and sizes. Tables of ratings, capacitor data, dimensional data and diagrams are included. Bodine Electric Co.

114 Transformer Guide — Complete engineering information on manufacturer's line of dry and liquid-filled transformers is presented in this looseleaf ring-bound catalog. Fully illustrated, provides details of construction, performance and dimensional data. Also discusses care and maintenance of dry-type and oil-immersed transformers. Marcus Transformer Co., Inc.

115 Distribution Transformers — Comprehensive technical specifications and other design and operating data on company's dry-type distribution transformers are presented in 28-pp Catalog 500. Catalog data covers dry-types, both single and three phase, to 500 kva, to standard ratings and voltages. Hill Transformer Co., Inc.

116 Substation Transformers — Eight-pp Bulletin CS-701 covers single- and three-phase substation transformers up to and including 10,000 kva through 69 kv. Illustrated bulletin details construction features, standard accessories and optional accessories. Kuhlman Electric Co.

117 Primary Distribution System — Proper installation of a primary overhead insulated distribution system is detailed in 20-pp Bulletin RCP-790. Includes data on each component, as well as step-by-step instructions for proper installation, splicing and termination, tables of electrical and physical characteristics of the conductors. Rome Cable Corp.

118 Metal-Enclosed Bus — Ratings and construction details of a line of isolated phase and nonsegregated phase metal-enclosed bus and bus auxiliary equipment are presented in 20-pp Bulletin 2604-1A. Contains a section on simplified planning procedure, as well as specifications, dimensions, and other data. I-T-E Circuit Breaker Co.

119 Trolley Busway System — Bulletin 75 contains 44 pp of information on company's 100 amp steel-enclosed trolley busway industrial electrification system. Illustrates and describes track, trolleys and accessories used in electrification of cranes and hoists, production lines, moving test lines, tools, and other moving equipment. Special sections cover installation planning and procedure, methods of mounting and typical installations. Feedrail Corp.

120 Expansion Fittings — Bulletin 12 describes a complete line of weathertight conduit expansion fittings to relieve strain of expansion and contraction in long runs of conduit. Illustrations are included to show engineering applications, assembly of units and typical installations. Spring City Electrical Mfg. Co.

121 Motor Control Selection — This profusely illustrated Quick Selector Chart is designed to simplify and speed selection of motor controls. Information includes motor control ratings, sizes, features, catalog numbers, ordering information, and listing of standard heater tables. Industrial Control Div., The Arrow-Hart & Hegeman Electric Co.

122 Instrument, Control Switch — Construction features of Type 210 instrument and control switches and their advantages are described in Bulletin 14B8112B. Dimensional data and diagrams are included. Allis-Chalmers Mfg. Co.

123 On Motor Controls — Profusely illustrated with product pictures and containing wiring diagrams and dimensional drawings and prices, 80-pp Catalog 14 gives size, weight and ratings information. An index lists catalog numbers and type identifications to facilitate finding information on particular equipment. One section lists replacement parts available and an-

other contains heater tables and motor charts and other data. The Arrow-Hart & Hegeman Electric Co.

124 Control Batteries — Twelve-pp Bulletin CP-539 describes a line of batteries for control, switchgear and auxiliary power. Construction details are illustrated and described, and specifications are given as well as discharge characteristics curves. C & D Batteries, Inc.

125 Reusable Battery — This 8-pp illustrated bulletin describes advantages and characteristics of a primary type battery offering fast activation, reusability and long activated shelf life. Discusses applications, electrical characteristics (energy, power discharge rates), construction, charging, activation, recycling, other technical data. Yardney Electric Corp.

126 Silicon Chargers — A chart for determining the proper size and model of silicon-rectifier charger to be used with stand-by batteries is incorporated in Bulletin 6258. Tabulating information on 27 basic rectifier models, the chart enables selection of chargers according to number of battery cells to be charged, output amperage and input voltage and phase. Also lists dimensions, weight, and mounting methods of each. Exide Industrial Div., The Electric Storage Battery Co.

127 Voltage Regulator — Bulletin 5.041 describes a 30-finger Regohm voltage regulator designed to handle heavy currents encountered in battery charger applications; and for exciter and main field generator control. Typical regulator performance data is tabulated. Electric Regulator Corp.

128 On Millivoltmeters — Operating principles, specifications, features, and ordering information on non-control and control millivoltmeters are presented in 28-pp Catalog C 10-1. Includes information on all control models such as Pyr-O-Vane, pulse Pyr-O-Vane, Protect-O-Vane, and the Pyr-O-Volt controller. Text is illustrated with photos, drawings and diagrams showing details of design. Minneapolis-Honeywell Regulator Co.

129 Rectifiers for Industry — Ratings, electrical characteristics and descriptive data on a line of silicon and selenium rectifiers and diodes are presented in 16-pp Short Form Catalog. Specification tables are included, as well as photos and diagrams. International Rectifier Corp.

130 Selenium Rectifiers — Featured in this 10-pp catalog are selenium rectifiers for efficient, economical a-c to d-c rectification in a wide range of sizes. Presents descriptive data and specifications for cell sizes from 1 in. sq to 12-by-16 in. and for stacks of practically any size. Also illustrates rectifier circuits and gives continuous d-c ratings. Syntron Co.

131 Vapor Cooling — Discussed in 8-pp Booklet B-7602 is the subject of vapor cooling for transformers. The illustrated publication covers both principles and practice. Comparison data on vapor cooling and air cooling included. Westinghouse Electric Corp.

132 Emergency Lighting — Illustrated and described in 8-pp Catalog 12 are units designed to provide emergency lighting instantly and automatically whenever a power failure plunges an area into darkness. Descriptive details on various types of units included. Electric Cord Co.

LUBRICATION

134 Lube Application Guide — Form C 10 W, 32 pp, presents recommendations covering lubrication of industrial and other machinery. Indexed by product and purpose, this book covers cup greases, bearing greases, gear lubes, high temperature lubricants, tool lubricants, cable treatments, as well as cutting oils, penetrating oils, others. Application devices are also described. Keystone Lubricating Co.

135 Bearing Lubrication — Reprint 5810 is a 26-pp manual on lubrication of miniature instrument bearings. It supplies data and information on types and brands of oils and greases available, and deals with oil and grease lubrication, properties of lubricating oils and greases, specifications, standard, and special lubricants. Blending charts, nomographs included. Miniature Precision Bearings, Inc.

136 Solid Lubricants — Described in 12-pp Bulletin 15 is a line of specialized lubricants, featuring high temperature, water resistant, extreme pressure, anti-seizing solid lubricant compounds. Among types covered are greases fortified with molybdenum disulfide, or graphite, oil dispersions of molybdenum disulfide or graphite, or graphite, solid dry film lubricants, others. McGee Chemical Co., Inc.

VALVES, PIPE, FITTINGS

137 Oil, Water, Air Valves — Twenty-pp Catalog 59-60 is divided into three colored sections according to type of medium — oil, water or air — and features manual, foot-operated, and solenoid valves. Overall pressure range of valves is from vacuum to 10,000 psi. Typical flow patterns and illustrations of specific valves, port sizes, and valve numbers are shown. Catalog includes section on how to locate company representatives. Barksdale Valves.

138 Control Valves — Illustrated Bulletin 581 describes Slim Line control valves, only 1-in. thick by 3 in. wide, which mount on any machine and can be manifolded into compact control centers. Presents solenoid, hand lever and ball actuated types. Hunt Valve Co.

139 Non-Return Valve — Eight-pp Bulletin S-2-B describes a single acting, non-return valve designed to close automatically when boiler pressure decreases below header pressure. Dimensional data and diagrams are included, as well as specifications. Golden-Anderson Valve Specialty Co.

140 Welded Steel Pipe — Welded steel pipe for industrial uses is featured in 40-pp Catalog 8558. It describes applications, advantages, standard specifications, production limits, linings, coatings, fittings, joints, and gives other essential information. Includes data tables, drawings; illustrations of typical installations. Armco Drainage & Metal Products, Inc.

141 Ductile Iron Products — This 36-pp illustrated catalog describes a complete line of ductile iron products, including pipe, tubing, casing, fittings and special castings. Catalog gives technical information including grades, specifications, dimensions and weights, uses and applications. American Cast Iron Pipe Co.

142 Hose for Diesels — Helpful data on best ways to overcome flexation and vibration problems of diesel pipeline connections are contained in Data Sheet 552. Charts and diagrams give recommendations for engine exhaust, air intake and oil lines that require flexible, leakproof connections to compensate for vibration, expansion, offset, misalignment, other problems. Allied Metal Hose Co., Inc.

143 Hose Fittings — Condensed Catalog 34, 8 pp, is generously illustrated and contains essential information on a variety of Le-Hi couplings and fittings for many types of industrial hose. Includes data on clamps, valves and manifolds, nipples, others. Hose Accessories Co.

INSULATION

144 Pipe, Equipment Insulation — Featured in 8-pp Publication IN-759 is a rigid hydrous calcium silicate pipe and equipment insulation effective for temperatures up to 1800 F. Physical properties are detailed, and specifications, design data and applications covered. Owens-Corning Fiberglas Corp.

Postage-free cards for ordering catalogs are on page 119. You may also use the cards to order literature mentioned in the ads.

145 Foamed Plastic Insulation — Advantages of foamed plastic tubing insulation for warm or cold fluid line piping are detailed in this illustrated bulletin. Physical properties of the material are listed. Mundet Cork Corp.

MECHANICAL POWER TRANSMISSION

146 Worm Gear Drive — Bulletin 3050 offers engineering information on right angle gearmotors, in ratings of ¼ to 30 hp, single reduction, with output speeds of 23 to 280 rpm. Cutaway view showing component features, as well as specifications and dimensional diagrams are included. The Louis Allis Co.

147 Adjustable-Speed Drives — Catalog 11058 is a 16-pp compilation of technical data which includes a discussion of the basic methods for operating d-c motors from a-c power sources. Typical schematic diagrams are included as representative of the more popular systems in general use. Specifications, speed and torque ratings and other data are included. Servo-Tek Products Co.

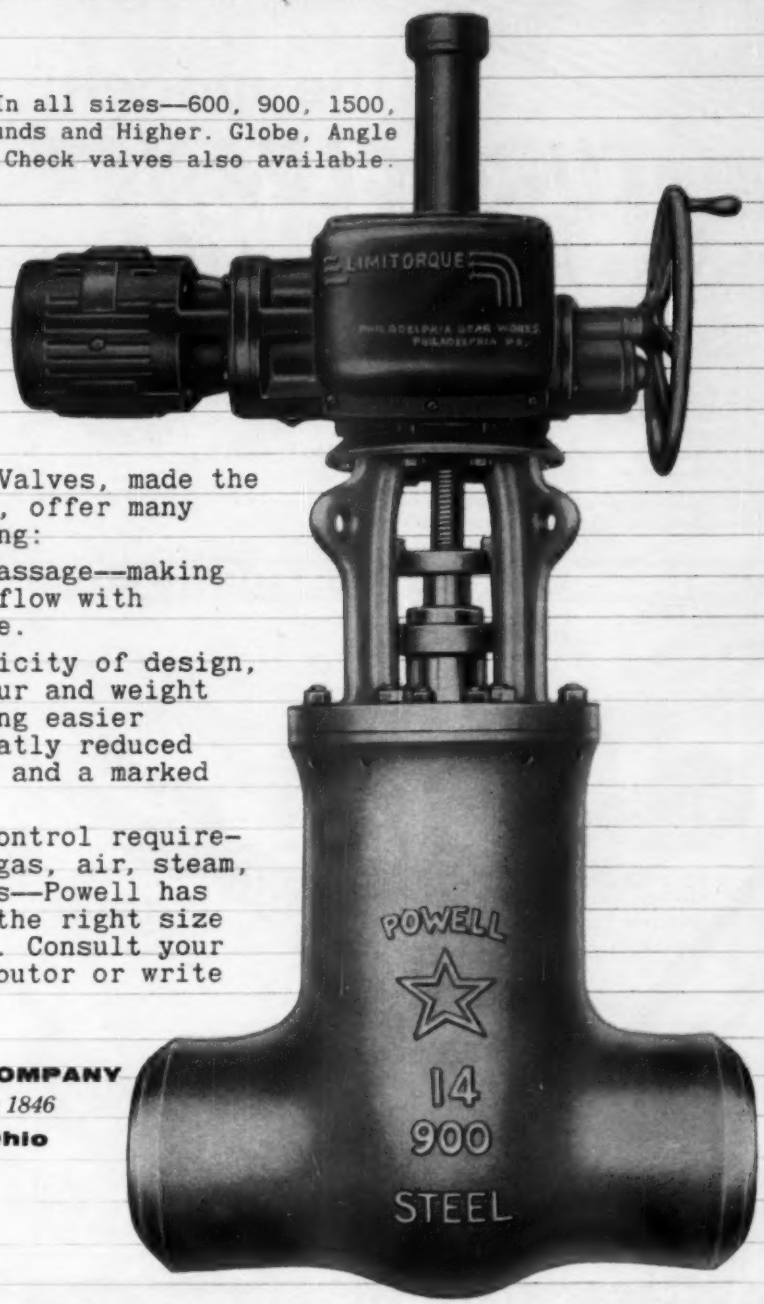
148 Variable-Speed Drives — Bulletin G-5812 describes variable-speed drives which provide precise, infinitely adjustable output speeds from a constant rpm motor source operating from standard in-plant a-c circuits. Includes mechanical construction features, condensed drive specifications, available speed variations and accessories. Reliance Electric and Engineering Co.

149 Variable Speed Belt — Described in this bulletin is a flexible, adjustable and laterally rigid belt designed for faster, easier installation, less vibration and exact speed control. Step-by-step photos show how to couple the belt. Manheim Mfg. & Belting Co.

150 Compact V-Belt Drives — Bulletin A-695 contains 42 pp of information

Specify POWELL PRESSURE SEAL GATE VALVES

In all sizes—600, 900, 1500, 2500 Pounds and Higher. Globe, Angle and Check valves also available.



Pressure Seal Gate Valves, made the superior Powell way, offer many advantages—including:

* Streamline flow passage—making possible maximum flow with minimum turbulence.
* Outstanding simplicity of design, smooth body contour and weight reduction—assuring easier installation, greatly reduced insulating costs, and a marked saving in space.

For all your flow control requirements—water, oil, gas, air, steam, and corrosive fluids—Powell has the right valve in the right size and the right metal. Consult your local Powell distributor or write directly to us.

THE WM. POWELL COMPANY
Dependable Valves since 1846
Cincinnati 22, Ohio

POWELL...world's largest family of valves

For more data circle 516 on Post Card

ROTOJET

The modern TUBE CLEANER

Fast • Powerful • Efficient

Only ROTOJET Tube Cleaners offer the simple, efficient, time-tested Rotocentric design. A single paddle maintains contact with the cylinder wall without depending upon centrifugal force. Motor won't stall at low speeds caused by heavy loads. Positive starting is assured with Rotojet motors driven by air or steam.

Rotojet water-driven Tube Cleaners are comparable in speed and power with air-driven types.

Send for bulletin showing motors, heads, and brushes for straight and curved tubes and pipes from ½" to 12" I.D.

Section of ROTOJET pneumatic motor showing simple design.

PNEUMATIC

Model C-525 ROTOJET Air-driven Motor with swing-frame head and universal coupling for 2½" to 3½" I.D. curved tubes.

Model S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼ to 3-13/16" I.D. straight tubes.

Model C-526 ROTOJET Air-driven Motor with single pin head and universal coupling for 1½" to 2½" I.D. curved tubes.

Model C-434 ROTOJET Junior Air-driven motor, flexible holder, expanding brush.

HYDRAULIC

Model C-322 ROTOJET Water-driven Motor with 3-arm head and universal coupling for 2¼" to 2½" I.D. curved tubes.

Model S-368 ROTOJET Water-driven Motor with combination drill head and universal coupling for 3¼" to 3⅞" I.D. straight tubes.

Model C-321 ROTOJET Water-driven Motor with short 4-arm head and universal coupling for 2½" to 3" I.D. curved tubes.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 517 on Post Card

on Dyna-V drives, its 1500 hp, featuring compactness and economy. Illustrated with photos and engineering drawings, bulletin explains construction features and advantages, and includes tables of pre-engineered drives and other tables giving horsepower capacities, belt speeds, center distance, sheave diam. Dodge Mfg. Corp.

151 Variable Speed Pulleys — Twelve-pp Bulletin 4101 describes variable-speed pulleys designed to eliminate freezing and sticking. Gives technical data on five sheaves designed for ratings of 2 to 15 hp, and includes photos and drawings showing construction features. T. B. Wood's Sons Co.

152 Belt Saver Pulleys — Bulletin 35-D describes advantages of company's line of belt saver pulleys designed to increase conveyor belt life. Tables of dimensional data and specifications are included. Sprout, Waldron & Co., Inc.

153 Quick-Seal Couplings — Illustrated 20-pp Bulletin Q.S.R. 58 describes Quick-Seal couplings for hydraulic and pneumatic applications. Discusses three types of couplings — straight-through, single check-valve, and double check-valve. Cross-section drawings point out major features of component, and complete details for each type given. Selection chart included. Titeflex, Inc.

FANS

154 Induced Draft Fan — Bulletin L-1A describes features and capabilities of induced draft fans designed to reduce stack maintenance costs while improving combustion in hand or mechanically-fired boilers. Schematic drawings, dimensional diagrams and photos are included. Lehigh Fan & Blower Div., Fuller Co.

155 Mechanical Draft Fans — Bulletin FD-905, 28 pp, describes a mechanical draft and other heavy-duty fans for a variety of industrial applications. Includes basic data for proper fan selection, performance tables, design sketches, component and installation photos of many types from kiln fans to cyclone compressors. Buffalo Forge Co.

INSTRUMENTS AND CONTROLS

157 Instrumentation Literature — Bulletin G2-1a is a 24-pp index of literature on instrumentation, including product catalogs, specifications, technical bulletins, industry bulletins, systems bulletins, and instrumentation data sheets. Includes alphabetical subject-company index of Instrumentation magazine articles. Minneapolis-Honeywell Regulator Co.

158 Calibration System — This 16-pp publication tells how to calibrate newest types of process control systems. Emphasizes testing and calibration of systems using proportional currents for signal transmissions and telemetering. Electrical and mechanical specifications for three calibration instruments are included, as well as instruments application data, diagrams showing how to "cross patch" or interconnect these instruments for measuring. Technique Associates, Inc.

159 Temperature Instruments — Temperature indicators, controllers and transmitters featuring corrosion-proof fiber glass cases and suitable for temperatures ranging from —400 to 1000 F are described

Super 70's "On Stream"

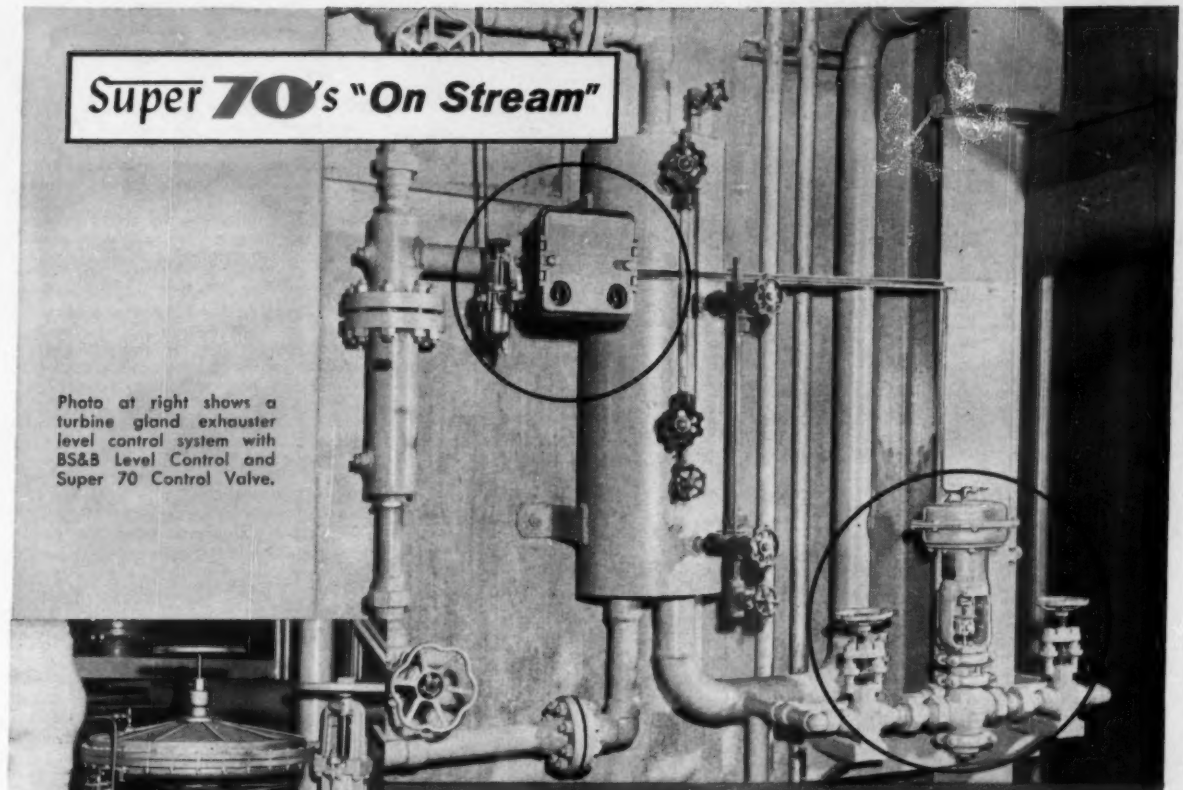


Photo at right shows a turbine gland exhauster level control system with BS&B Level Control and Super 70 Control Valve.

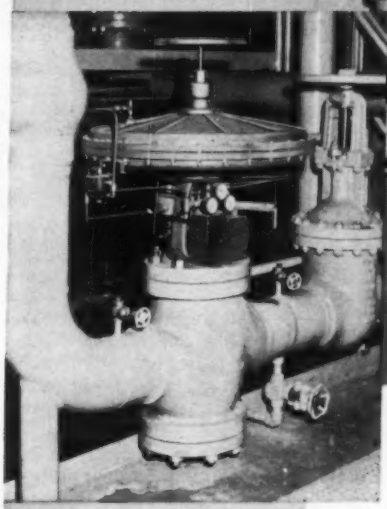


Photo above shows a BS&B pressure-balanced deaerator level control valve, complete with valve positioner, reverse acting relay and booster relays.

BS&B CONTROLS . . .
"On The Job" At Conesville!

Conesville No. 2, one of two new 125,000 KW steam-electric generating units for Columbus and Southern Ohio Electric Company, is now "on the line" at Conesville, Ohio.

BS&B Controls make up an important part of the controls system of this plant, with Super 70 Control Valves installed in Heater Drain, Steam Reducing and Water Supply Services. BS&B Level, Pressure and Temperature Controllers also play an important role in this plant's automatic operation.

Conesville No. 1, a "sister" unit now under construction for C and SOE, is similarly equipped with BS&B Controls and will go into service sometime early this year. BS&B personnel worked closely with the staffs of C and SOE, and Ebasco Services Incorporated, Engineers and Constructors, in the design, application and operation of these control systems.

Next time you have a new station "on the boards," specify BS&B Controls right down the line. They're dependable, efficient, and cut down maintenance costs. You'll get application engineering assistance, too!

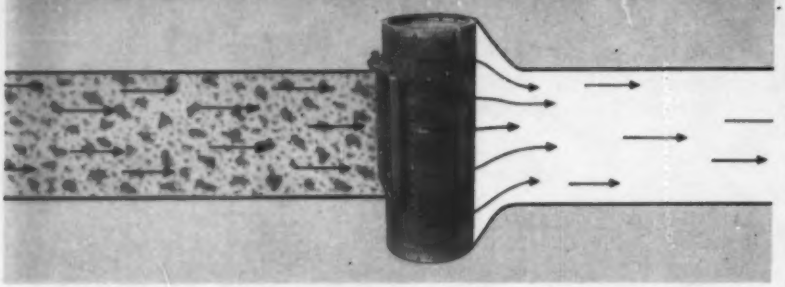
SUPER BS&B 70

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-R4
7500 East 12th Street Kansas City 26, Missouri

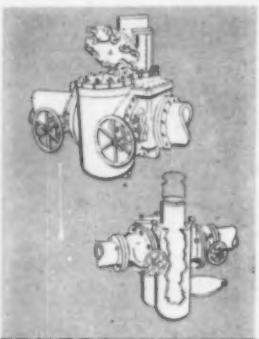
For more data circle 518 on Post Card

ELLIOTT STRAINERS

assure "trouble-free" clean liquids



For over 50 years, Elliott strainers have proved themselves in power and industrial plants everywhere. Removing objectionable solids that could cost thousands of dollars in lost time and damaged equipment, they keep liquids clean and free of foreign matter.

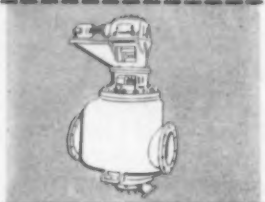


ELLIOTT TWIN STRAINERS
TYPE A, for water and other liquids

Provides continuous flow, since one strainer basket is in service while the other is removed and cleaned. Available sizes 4" to 24" for 125 psi, and 4" to 12" for 250 psi pressure. Straining-basket mesh ranges from 1/32" to 3/8". Also available: back-flushing strainers in manually-operated and rotary spray types, sizes 4" to 24".

TYPE V, for lube oil, fuel oil, viscous liquids

Uses large-size baskets to facilitate unrestricted fluid straining. Sizes from 1" to 8" for 125 psi, 1 1/2" to 10" for 300 or 500 psi, straining perforations from 3/8" down to fine wire mesh.



TYPE K SELF-CLEANING STRAINER
for removing large amounts of foreign matter in water

Cleans itself automatically and continuously by back-flushing the straining units. Standard sizes 4" to 24", pressures 25 to 125 psi, straining units 1/32" to 3/8" mesh. Available with AC or DC motor, low power requirement.

TYPE F SINGLE STRAINER
where flow can be interrupted for cleaning

Excellent for liquids not containing large amounts of foreign matter, or batch processes. Quick-opening cover. Sizes 2" to 24" for pressures up to 125 psi, basket mesh 1/32" to 3/8".

For further details, call your nearby Elliott District Office or write Elliott Company, Accessories Department, Jeannette, Pa.

A7-3

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

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in a series of Specifications Sheets, 12-1451T-1 to 5. Design, construction and performance details are given. Fischer & Porter Co.

160 Manometry Explained — Theory and application of manometers is covered in this 6-pp bulletin. Principles and terminology encountered in manometry are explained, different types of manometers are described, and a number of manometer applications with working diagrams are presented, along with conversion tables for different fluids. Dynametrics Corp.

161 Temperature Controllers — Specification S1010-6 describes electronic temperature controllers for industrial heating and cooling operations. A table of electrical ratings and switching actions is included, as well as specifications and dimensional diagrams. Minneapolis-Honeywell Regulator Co.

162 Pressure Transmitter — Bulletin WG-1824 Supplement A describes a differential pressure transmitter designed for controlling a distant indicator, controller, or other electrically operated receiver. Bulletin describes applications, operation, construction details, advantages, specifications. Yarnall-Waring Co.

163 Wheatstone Bridge — Data Sheet E-53 (1A) describes features of a Wheatstone bridge, used in resistance measurements or production checking of resistors. The sheet provides complete specifications including a table listing maximum applied bridge voltages. A schematic diagram is shown as well as interior views. Leeds & Northrup Co.

164 pH Recorder — Described in Product Specifications E12-4, E67-5 and E67-6 is a pH recorder consisting of electrode assembly and amplifier and a potentiometer recorder. Charts, tables, and drawings aid in proper selection according to application. Bailey Meter Co.

EQUIPMENT MAINTENANCE

165 Wear-In Compound — Bulletin 120 describes a wear-in compound designed to eliminate damage due to improper breaking-in of new or rebuilt machinery and protect against galling, seizing, scuffing, scoring, tearing, scratching and excessive abrasion. Selection information included. The Alpha-Molykote Corp.

166 Do-It-Yourself Parts — "How to Make Your Own Machine and Repair Parts . . .", 24 pp, is designed to help solve maintenance and repair part problems. Covers care and trouble-shooting of machines and equipment, also machining and welding techniques; contains drill hole tolerances and grinding limits chart. Many types of parts are almost universal in use, and this booklet pictures a number of these with case histories covering use of Stressproof, a high strength all-purpose steel bar. LaSalle Steel Co.

167 Freon Solvents — Applications of Freon solvents for hand-cleaning operations as well as in degreasing equipment are detailed in this product bulletin. Properties of Freon solvents are tabulated and advantages pointed out. E. I. du Pont de Nemours & Co.

168 For Corrosion Prevention — Bulletin 93XG describes a metallizing system consisting of a series of techniques developed through use of treated pure

Hall Industrial Water Report

VOLUME 7 APRIL 1959 NUMBER 2

Let's Keep Steamed Up

Large or small, the boiler house is the heart of most industrial plants. It must make steam to maintain production. When there is trouble, production losses from lack of process steam or power may be far more costly than the actual repairs.

Water problems are high on the list of the causes of unscheduled boiler house outages. To minimize these problems, skilled Hall engineers are ready to help you establish a sound, practical water conditioning program. And they can help you with other water problems in cooling systems, process operations and waste disposal.

Spreading Oil on the Water

Due to construction work, a small plant had only one boiler available. Then a fuel oil heater sprung a leak. Suddenly the one boiler had about 200 gallons of oil in it.

Ordinarily the boiler would have been shut down for a complete cleaning. However, that was not considered possible at the time of the accident. Recognizing that he was in real trouble, the engineer called Hall Laboratories.

Fast action was necessary. Most of the oil had to be removed from the boiler without taking it out of service for more than a few hours at night. Hall engineer C. F. Raines fed large quantities of caustic soda and wetting agent while lightly firing the boiler, venting steam to the atmosphere and blowing down heavily. Then the boiler was overflowed through the vent. This took from midnight until 4:00 a.m.

When the boiler was put back on the line at 5:30 a.m., the usual zeolite-treated feedwater was replaced with hard raw water so sludge to absorb oil would be produced in the boiler water. Several days later there was time over a week-end to do a more complete boiling-out job.

In spite of the heavy oil contamination the emergency action kept the boiler in service. Furthermore, when a quick inspection was made after the week-end boil-out there was no evidence of oil on the internal surfaces.

Well Water Changes For the Worse

About three years ago there was a radical change in the well water used by an eastern town. Hardness soared from a constant 8 to 9 gpg to a fluctuating 25 to 40 gpg.

A small local factory had successfully used the softer well water for boiler feedwater by pretreating it with lime and soda ash in a hot-process softener. Trouble came with the new well water because the widely fluctuating, high hardness made adequate control of chemical feeds well-nigh impossible. Calcium carbonate deposition completely plugged the vent condenser on the deaerating heater and stopped a feed pump by causing it to bind.

Hall engineer F. R. Duesing recognized that water conditioning procedures would have to be adjusted to accommodate fluctuating hardness of the feedwater. He therefore used a dispersive to stop the deposition of calcium carbonate in the pre-boiler system. This was the answer. After more than two years' operation there has been no further scale formation on the feed pumps or deaerator vent condenser.

Blowdown was another problem. It was excessively high because of the high solids concentration of the treated well water. By instituting the use of Hagan C-1 Antifoam, Duesing was successful in doubling the normal concentration of dissolved solids in the boiler water without impairment of steam quality. Subsequent inspections of the turbine and boiler superheaters have confirmed that steam quality is good.

Removing Old Scale From Boilers

Scale forms in a boiler in response to specific physical and chemical circumstances. Significant changes in water composition, chemicals used for conditioning, or amounts of chemicals fed can cause the scale to slough off. Accumulation of loosened scale can then upset circulation, obstruct blowdown connections, plug tubes and headers and result in unsafe operation and repairs.

To avoid trouble, a plant with dirty boilers should preferably clean them mechanically or chemically before changing to a more effective water conditioning program. If this is not possible for some reason, such as steam load requiring that all boilers be kept in service, the recommendations of the Hall engineer should be closely followed. He will base his recommendations for establishing desired boiler water conditions on his experience in getting rid of old deposits slowly enough to avoid serious difficulty.

Thermocouples Tell Tube Failure Story

Thermocouples, used to record tube temperatures, were resorted to by a midwest paper mill to warn of scale deposition in the water walls of their boiler. Sludge and sodium aluminum silicate (analcite) scale had caused trouble, and zeolite softening of makeup water didn't stop the analcite. Readings showed tube temperatures went from 450F to over 550F in 60 days.

Hall engineer M. L. Mitchell recommended a newly developed Hagan dispersive which is especially effective in promoting tube rinsing in regions of high heat transfer. The results were dramatic. Tube temperatures leveled off—and when the boiler was next cleaned, continued use kept temperatures at normal levels.

Water is your industry's most important raw material. Use it wisely.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

HALL LABORATORIES
DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.
In Canada: Hagan Corporation (Canada) Limited, Toronto

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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NOW···GLOBE OFFERS···
two new INTERCHANGEABLE trays for support of cables, wiring and tubing

★ Engineered for uniform design and easy installation
★ Steel or aluminum construction
★ Complete accessories for SPEEDIER Installation
★ No sharp edges to damage cables
★ Complete interchangeability

Now, for the first time, two types of cable trays, one a ladder type and the other a basket type, are available to be used INTERCHANGEABLY at any given location, depending on the type and weight of the cables to be suspended. The advantages of each type tray can thus be used to the fullest extent. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is intended for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants, in modernization, and for power distribution in all types of manufacturing processes. A new catalog, just off the press, gives full information and installation techniques. Ask for your FREE copy today.

Distributors are to be found in all principal cities— consult the yellow pages in your phone book under "Gratings" or "Conduits" for the one nearest you.

109

PRODUCTS DIVISION

The **GLOBE** *Company* MANUFACTURERS SINCE 1914

4022 SOUTH PRINCETON AVENUE, CHICAGO 9, ILLINOIS

For more data circle 521 on Post Card

metals bonded to a steel base by metallizing. Advantages and typical applications on broad range of equipment are detailed. Metallizing Engineering Co., Inc.

OTHER EQUIPMENT

169 Feedwater Heater — Catalog M582 describes a line of feedwater heaters used by power plants in the exacting transfer of heat from bleed steam to feedwater. Cross-section drawing depicts various parts. Southwestern Engineering Co.

170 On Stainless Tubing — This 10-pp report covers a successful application of light wall stainless steel tubing for main surface condensers in power plants. Combines interpretive text material, tabular test data and performance graphs on an installation. Stresses stainless' resistance to corrosion and erosion. Describes improved techniques for installation of stainless tubing in tube sheets. Alloy Tube Div., The Carpenter Steel Co.

171 Industrial Nozzles — Catalog 59 contains 32 pp of listings and data on nozzles for industrial spraying applications. Specific data on spray angles, dimensions, types of connections, and capacity vs pressure for all standard nozzles are presented in simplified selection tables. Wm. Steinen Mfg. Co.

172 For Desuperheating — Bulletin 1056 describes a carburetor-type desuperheater capable of being controlled to supply steam at a temperature within ±5 F of plant requirements. Explains method of control and gives range of control attainable. Also describes structural details, system arrangements of components, and mechanical specifications. Copes-Vulcan Div., Blaw-Knox Co.

174 Packaged Chillers — Sixteen-pp Bulletin 8325 describes redesigned packaged water chillers for air conditioning and industrial cooling applications. Outlines advantages of the units and illustrates outstanding mechanical specifications. Schematic wiring diagrams show control panel wiring, control circuit wiring for city water operation and cooling tower operation. Also shown are pneumatic control connections. Pressure drop data and condenser water requirements are tabulated. Industrial Div., American-Standard.

175 Fuel Oil Heaters — Eight-pp Bulletin 585 gives specifications and descriptive information on fuel oil heaters used on the suction side of pumps for heating such viscous fluids as Bunker C oils, asphalt etc. to make them more pumpable. Two principal types covered are tank suction type heater and line type heater. Brown Fintube Co.

176 Fire Fighting Equipment — This 28-pp brochure covers interior fire extinguishing systems, portable extinguishers, cabinets and other inside fire control products. Among systems described are automatic sprinkler, carbon dioxide, dry chemical, foam and smoke detection. Details on hose and extinguisher cabinets are included, data on nozzles, valves, connections. The Fyr-Fyter Co.

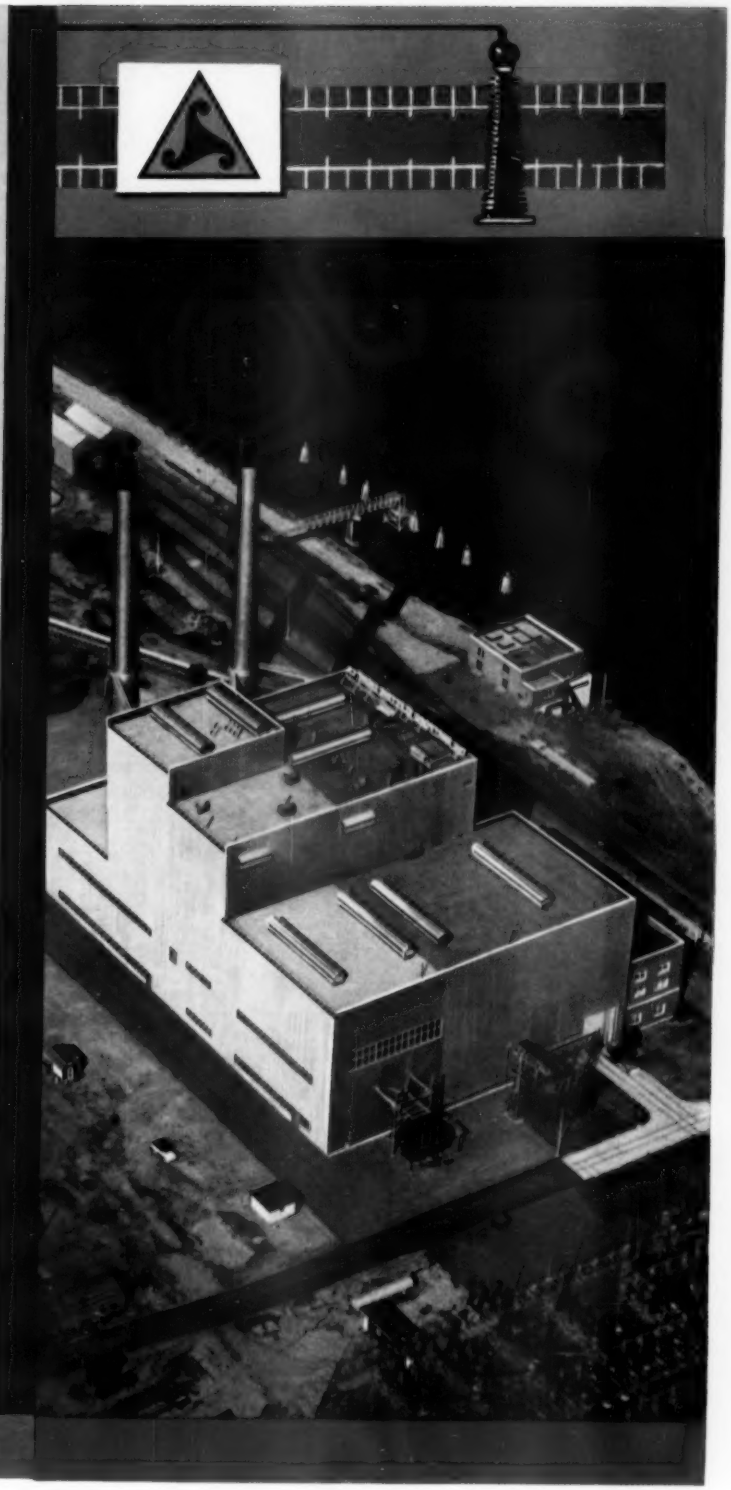
177 Laboratory Supplies — This 12-pp price list announces latest prices for a wide range of laboratory supply items, including water analysis sets, conductivity equipment, colorimetric comparators, glassware and supplies, chemical reagents, and company's photometer with replacement accessories. Betz Laboratories, Inc.

More Power for Connecticut

Keeping pace with the growing power demands of Connecticut, the second unit in the Middletown Station of The Hartford Electric Light Co. at Middletown, Connecticut, was placed in operation in November, 1958. With almost twice the capacity of the first unit, the new 115,000 kw reheat unit with its accompanying auxiliaries was designed for the highest practicable efficiency.

Probable future station expansion was a key factor in the selection of the original project site on the Connecticut River. Room is available for three more units of larger capacity which, when completed, can increase the total plant capacity to 875,000 kw.

Stone & Webster Engineering Corporation designed and constructed both units at Middletown Station and is proud to have served The Hartford Electric Light Company on this and other important projects over many years.



STONE & WEBSTER ENGINEERING CORPORATION
A SUBSIDIARY OF STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

Steel stack is protected from corrosion by concrete lining made with **Atlas Lumnite Cement**

At Pennsylvania Power Company (New Castle, Pa.) this stack interior was recently gunited with a mixture of Lumnite calcium-aluminate cement and sand aggregate.

This monolithic concrete lining will protect the stack from corrosion, abrasion and high temperatures.

Concrete made with Lumnite cement can be cast in place, plastered against the shell or gunited. It reaches high strength in 24 hours.

For convenience, manufacturers of refractories offer castables bonded with Lumnite cement – packaged mixtures ready for use with just the addition of water. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas," and "Lumnite" are registered trademarks

L-183

Universal Atlas Cement
Division of
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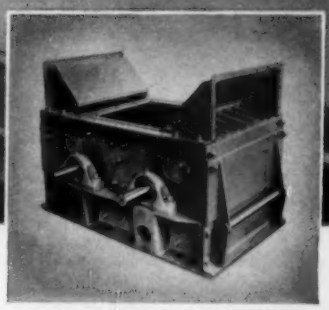
STEPHENS-ADAMSON

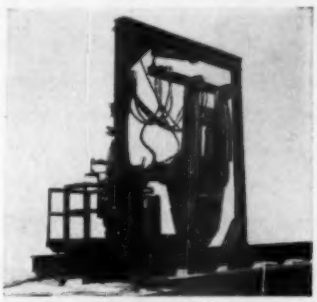


S-A RING TYPE, DOUBLE ROTOR KNITTEL CRUSHER — Crushes lumps while in suspension. Maintains full capacity with wet coal — no clogging. Greater capacity — less space required.

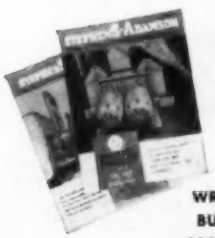
COAL HANDLING SYSTEMS
increase tonnage, lower costs!

When STEPHENS-ADAMSON engineers and builds a coal handling system, over a half-century of "know-how" in the design of unloading, storing, crushing, reclaiming, sampling, and distributing systems is put to use. S-A experience dates back as far as the early beginnings of electric power and includes the engineering of giant systems such as the mammoth Detroit-Edison and New York State Electric installations to a newly engineered power plant in Bombay, India. Large or small, an S-A engineered system means more kilowatts per ton and years of dependable service.

Backing up the "know-how" and experience is a quality-engineered line of components, each providing an exclusive combination of features — many of them carrying patents by S-A engineers. Put S-A engineering skill to work for you . . . write for full information today!



S-A HYDRAULICALLY POWERED CARQUAKE — Maximum efficiency in unloading hopper cars with minimum noise. One man operation. No expensive overhead structures — a completely self-contained unit.



WRITE FOR BULLETINS 858 and 658

S-A
MATERIALS HANDLING PRODUCTS
SEALMASTER BALL BEARING UNITS

ENGINEERING DIVISION
STEPHENS-ADAMSON MFG. CO.
GENERAL OFFICE & MAIN PLANT, 86 RIDGEWAY AVENUE, AURORA, ILLINOIS
PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI
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DIAMOND

...NOW READY AND ABLE TO IMPROVE the CLEANING of—

Shot cascading over horizontal tubular surfaces and through vertical air heater tubes, does an excellent job of removing soot and ash deposits from difficult-to-clean surfaces and those which foul rapidly.

Shot Cleaning has proved itself in more than 30 installations in the United States and in more than 800 installations in Europe. Many installations represent exceptionally difficult cleaning problems such as tubular air heaters, economizers and superheaters in black liquor fired boilers in paper mills. In a large central station, the system is now keeping air heaters clean which previously had to be water washed approximately every eight months, each washing requiring a three day boiler outage. With Diamond Shot Cleaning, draft losses are uniformly low and water washing has been eliminated entirely.

Shot is spread by distributors and cascades over tube surfaces ricocheting from tube to tube, or from side to side of internal surfaces of vertical air heater tubes. Much of the ash removed is carried off by flue gas. Heavier particles fall into the shot hopper and recirculate with the shot until broken fine enough to pass out with the gases. Shot accumulated in the hopper is lifted pneumatically to the storage area and reused continuously. Areas which tend to foul rapidly can be kept completely clean by increasing the length of the shot cycle (it can be continuous if necessary) without disturbing boiler operation.

Over a period of years Diamond has conducted extensive research in shot cleaning, as a part of our half century policy of providing the best in boiler cleaning. To supplement this program, Diamond has acquired U.S. rights to the Broman-Ekstrom system used in Europe.

WRITE FOR BULLETIN 2145AB ON
DIAMOND-BROMAN SHOT CLEANING

Diamond Gives You
BETTER BOILER CLEANING
At Lower Cost

Diamond

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

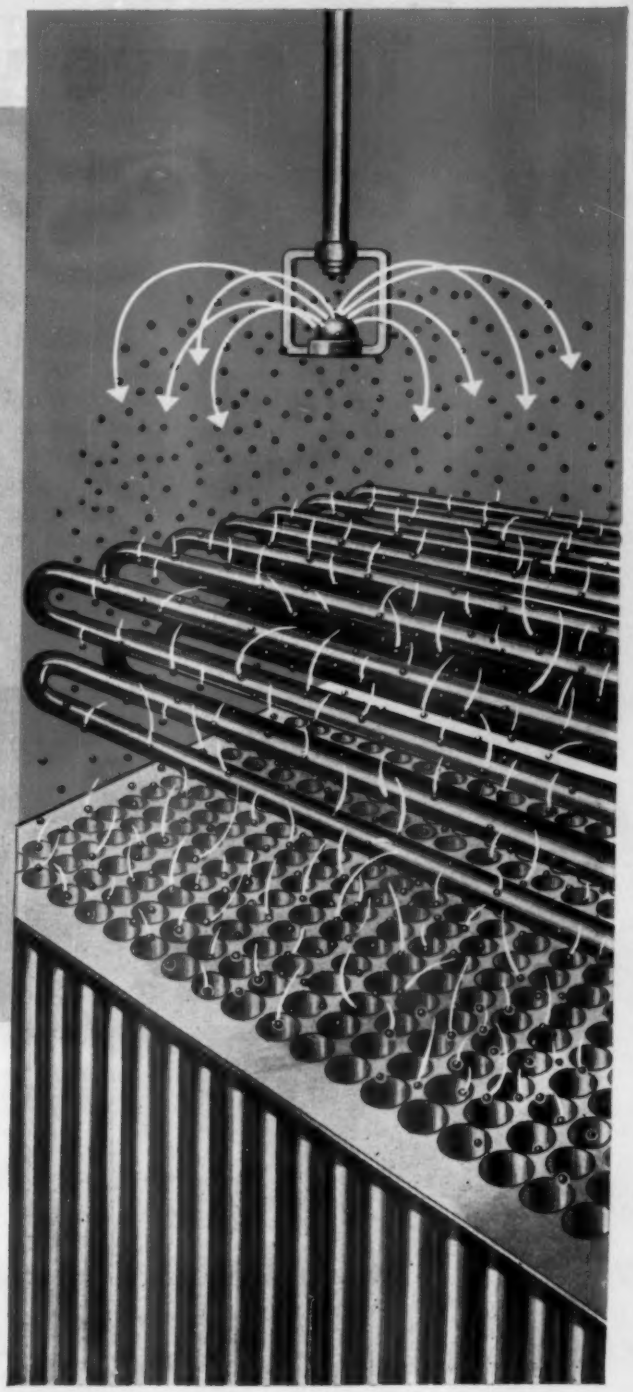
Shot Cleaning System

TUBULAR AIR HEATERS

ECONOMIZERS

HORIZONTAL SUPERHEATERS

REHEATERS



8254

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To serve you better we created a new division

Now you can benefit from the combined engineering backgrounds and product lines of three American-Standard* divisions—American Blower, Ross Heat Exchanger, and Kewanee Boiler—consolidated into *one* organization!

Here is *one-source* responsibility for quality and performance in equipment that is designed, engineered, and manufactured to work together. You draw from a product line unsurpassed in the industry . . . one that encompasses air conditioning, heating, ventilating, heat transfer, dust collection, and fluid drives.

There are engineer-staffed offices in all principal cities to work with architects, consulting engineers, and contractors with equipment selection and on-the-job problems. We welcome the opportunity to serve you. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.

Firebox, scotchtype, and package boilers for heat, steam, and industrial power.

Mechnical draft fans for induced and forced draft duty in power plants.

Balanced-flow surface condensers for condensing turbo-generator exhaust steam.

Fluid drives for adjustable-speed control of feed-pump flow and fan volume.

Dust collectors and precipitators for recovering fly ash, eliminating dust.

Standard and engineered heat exchangers and feedwater heaters for every duty.

* AMERICAN-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS

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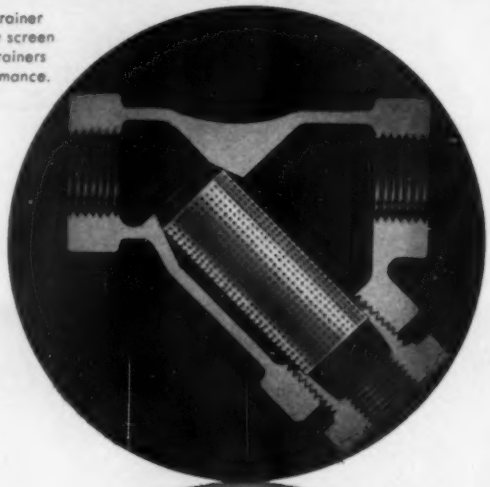
protect your equipment against scale and dirt

Exterior view of NEW Sarco Type "AT" Pipe Line Strainer. Note 45° blow-down angle to facilitate piping away from strainer.

with this

NEW SARCO TYPE "AT" PIPE LINE STRAINER



Cutaway of NEW Sarco Type "AT" Strainer shows sediment collection chamber below screen. Standard screen used in Sarco "AT" Strainers is key to their uniformly successful performance.

Examine one of the new Sarco Type "AT" Strainers and you'll notice at once that its design is a marked improvement over that of contemporary strainers... in three important ways:

The Sarco screen, key element of the unit, fits tightly into a long, tapered screen seat. This feature absolutely stops the by-passing of particles around the screen. Secondly, the rigid, welded construction of heavy-gauge brass makes sure the fit will remain tight, even when trapped sediment builds up pressure.

Third, you'll see that the new AT is easy to clean. No sharp edges or weave crevices in the screen for particles to cling to. Blow-down cleaning is simplified by the 45° angle construction.

Write for Sarco Bulletin No. 1210B which gives dimensions, capacities, and technical data. 7317-8

NOTE THIS ADDED PROTECTION AND CONVENIENCE

1. Bodies of heavy-duty 250 psi semi-steel. Tensile strength to 30,000 # per square inch minimum.
2. For maximum strength, bodies are reinforced with external rib.
3. Long, tapered screen seat assures correct screen position and tight fit without buckling.
4. Cap design provides a sediment collection chamber below screen.
5. Generous proportion of open screen area in relation to pipe size minimizes pressure drop.

SARCO
COMPANY, INC.
635 Madison Avenue, New York 22, N. Y.

STRAINERS • STEAM TRAPS • TEMPERATURE CONTROLLERS • HEATING SPECIALTIES

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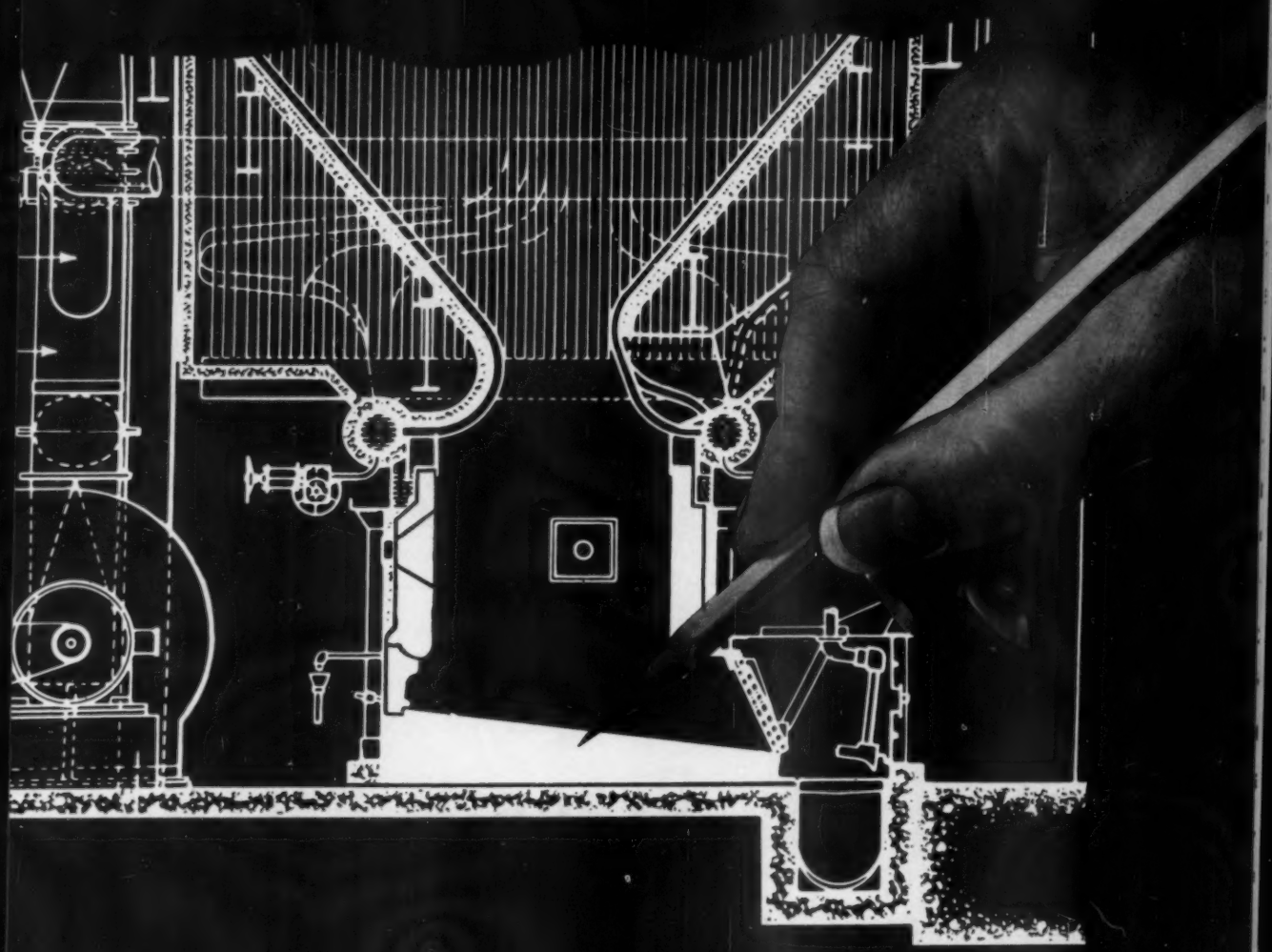
How to draw the line on ashpit maintenance



"Let's put Kaocrete here"

Relining ashpits is expensive and time-consuming. That's why more and more utilities and industrial companies are specifying a heavy-duty refractory castable such as B&W Kaocrete D. On job after job, it has withstood the heavy abrasive or erosive attack of sprays, jets, rakes or shovels.

The reason? Specially designed Kaocrete D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It saves time because it can be poured or gunned into place. For less severe abrasive or erosive conditions, B&W recommends Kaocrete A.

Get the facts and figures on these B&W Refractory Castables from your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

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R-949

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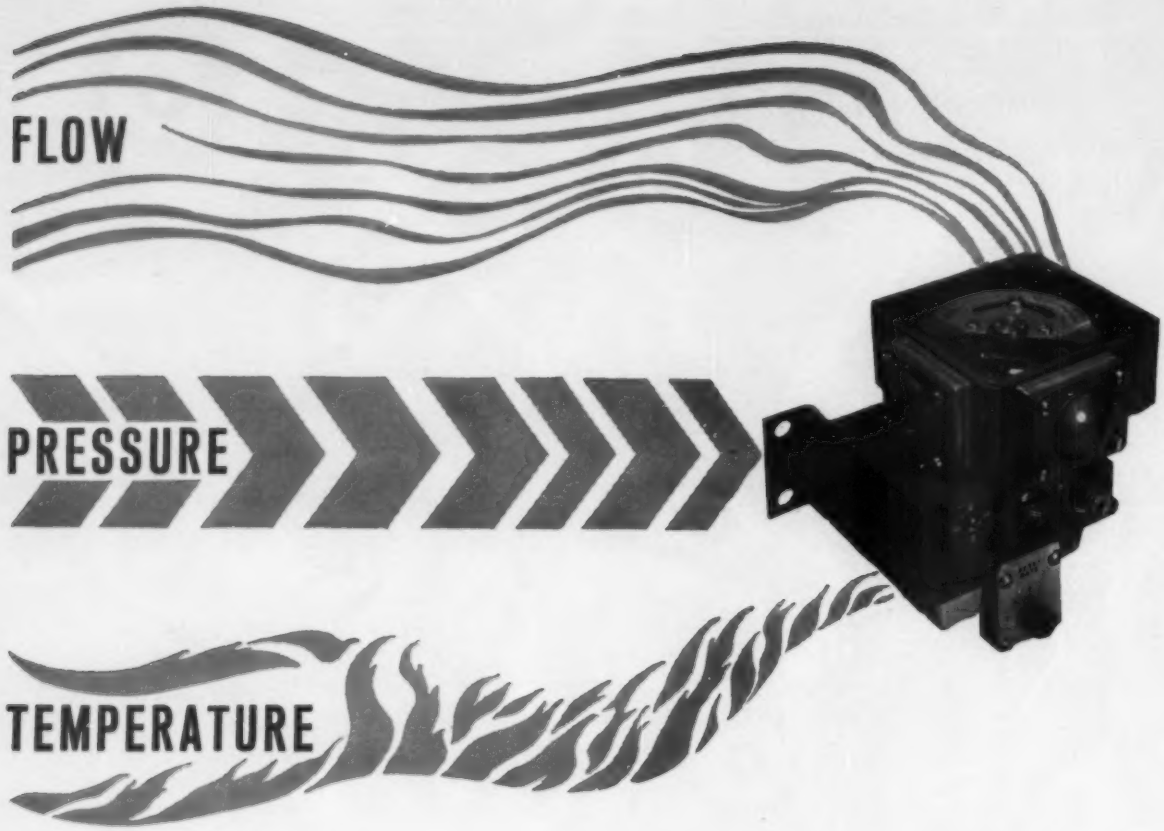


Control Any Process Variable

with a system based on

REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

For more data circle 529 on Post Card

Another addition to the Vogt line of TOP QUALITY valves . . .

Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

Address Dept. 24A-FPE for literature

Series 2801 Gate Valve
Illustrated

Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

Vogt GENERAL GP PURPOSE Vogt FORGED STEEL VALVES

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

FORGED STEEL

VALVES

For more data circle 530 on Post Card

A plant built on the philosophy of "don't accept anything at face value"...

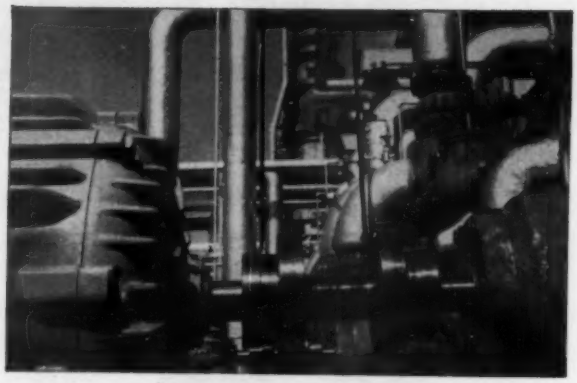
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 5204 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.

This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL

FAST'S Couplings

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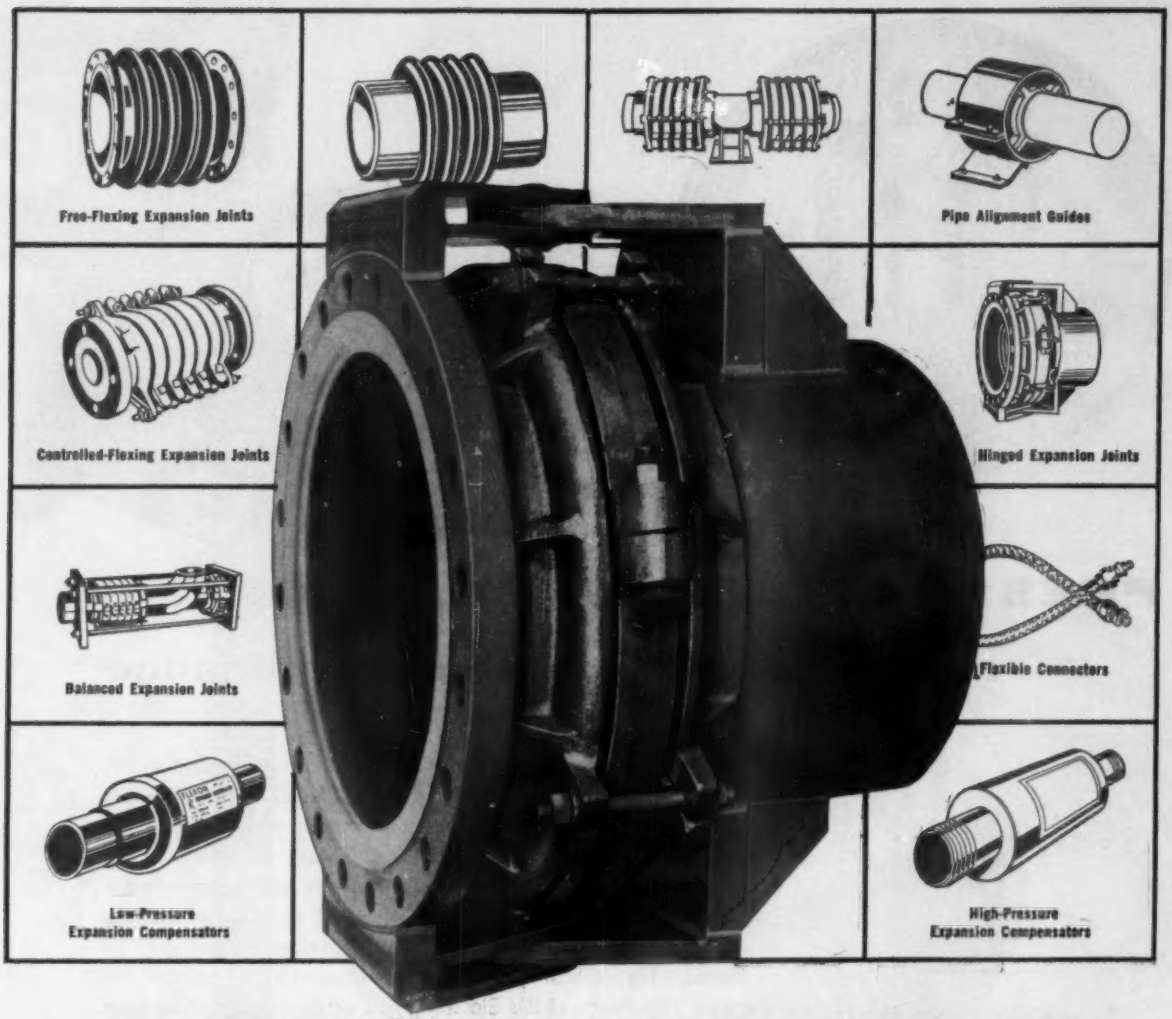

THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

For hinged or any other type of standard or special expansion joints – your best bet is FLEXONICS. Here's where you'll find the equipment, the experience, the skill to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from five FLEXONICS warehouses. They all add up to expansion joints that you can *install and forget* – plus expansion compensators, flexible connectors, the all-new FLEXONICS pipe alignment guides and other piping accessories.

Today—write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

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EJ-240

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In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

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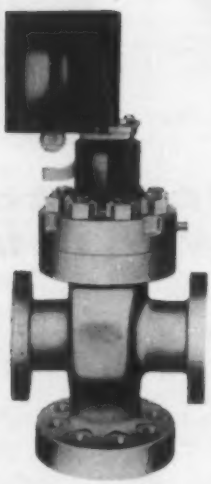
PRESSURE LOADED SEATING

minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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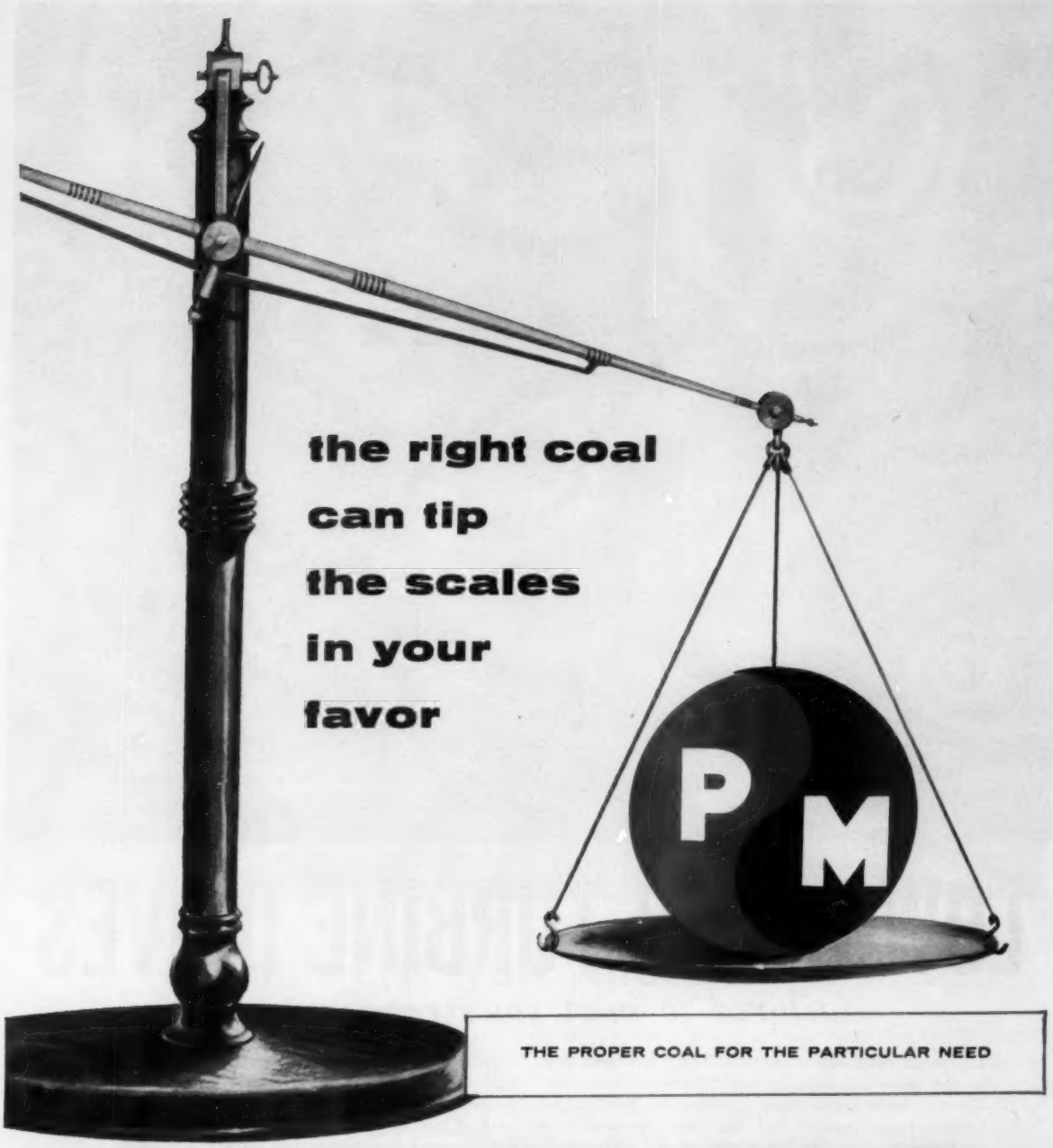

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Serving Industry Since 1883

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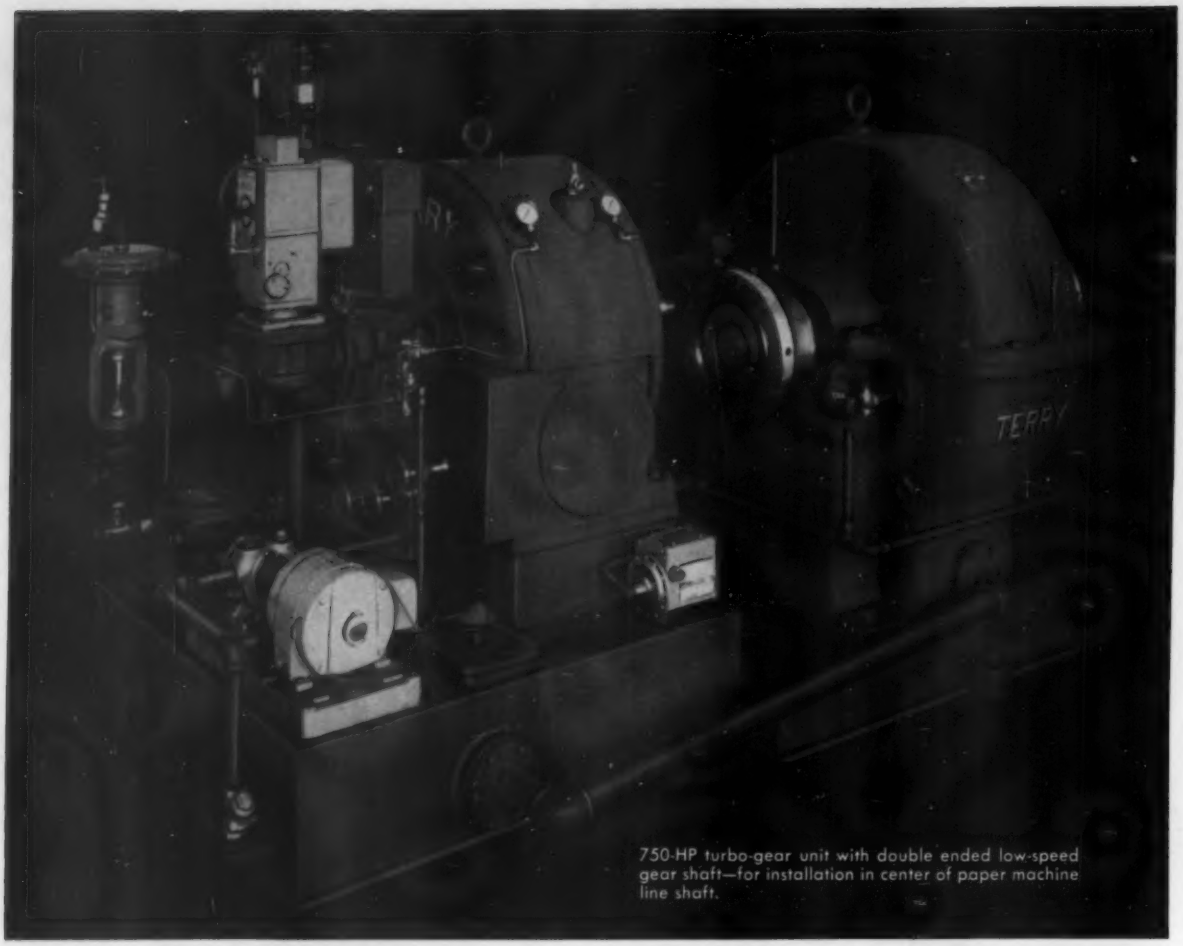

750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering*.

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1212

For more data circle 535 on Post Card

We can give you valuable help

In designing, installing or converting water softening equipment

There's no charge for the services of one of Morton's Consulting Engineers at any stage of your work with water softening systems. Many architects and engineers have already found that calling in a Morton man can save time and work and will result in water softening installations that provide maximum efficiency and the greatest economy of operation.

The Morton Consulting Engineers have experience with all types of water softening systems for all types of uses. The assistance they offer is well worth an inquiry. If you think a Morton Consulting Engineer could be of assistance to you, just send in the coupon today.

I would like to know how a Morton Consulting Engineer could help me_____

_____

I understand there is no charge for this service.

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Title_____

Company_____

Address_____

City_____ Zone____ State_____

MORTON SALT COMPANY

INDUSTRIAL DIVISION

Dept. PE-459, 110 No. Wacker Drive, Chicago 6, Illinois

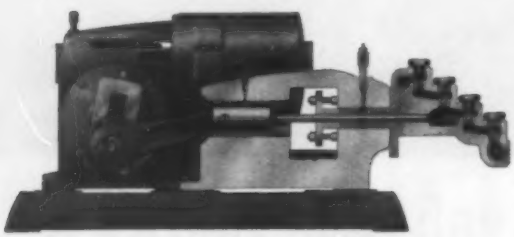
For more data circle 536 on Post Card

HOW TO METER SLURRIES ACCURATELY

Few pumping jobs present more complex problems than the accurate metering of slurries. Since they are often abrasive, slurries can make the selection of pump parts extremely difficult. Minute particles settling out in the packing can score a plunger beyond usefulness in minutes. And viscous, tacky slurries can limit ball check freedom and reduce accuracy. But even the toughest slurries *can* be metered accurately . . . by adhering to good slurry handling practice, and by choosing the right pump for the job.

Keep Slurries In Suspension

Several practices that have proved valuable in this difficult service are aimed at keeping the solids in suspension. Suction and discharge lines should be as short as possible. The supply tank should always be well agitated. And if packed plunger pumps are used, stroking speed should be held between 45 and 75 rpm to minimize settling.



Standard Motor Driven Controlled Volume Pump

Choosing The Right Pump

Controlled volume pumps are manufactured in a sufficient variety of designs to provide a full range of desired characteristics for slurry service. An economy pump such as Milton Roy's H20® can handle slurries up to 5% by weight. Standard motor driven pumps, with minor modification, can handle much denser slurries. And the new ODS (Oliver Diaphragm Slurry*) controlled volume pump can easily manage slurries containing up to 60% solids by weight.

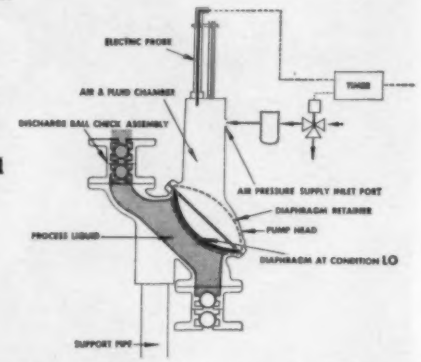
*Manufactured under exclusive license granted by Dorr-Oliver Inc.

Packed Plunger Pumps

Because the entire liquid end of a packed plunger pump is in intimate contact with the slurry, considerable attention must be paid to materials selection. Ball checks and plunger should be as hard as possible, and seats should be relatively soft. Balls are usually made of Hastelloy D, 440 stainless, or ceramic, while 316 stainless is standard for the seats. The plunger must be extremely hard, and high strength sintered alumina is generally recommended.

Proper packing maintenance in slurry service demands that packing be flushed out continuously. An internal flush, continuously bleeding a small amount of liquid along the plunger, is the most common. Dangerous liquids may require an external flush arrangement. Liquid is continuously fed in on one side of the lantern ring, drawn around the plunger, and carried away from the other side.

The ODS Controlled Volume Pump



Capable of pumping 180 gph of the densest slurries at accuracies of ± 2% against pressures up to 90 psi, the ODS has no plunger, no packing. It is based on the Oliver Diaphragm Slurry pump design principle which consists of two opposed chambers separated by a slack diaphragm. A three-way solenoid alternately pressurizes and bleeds air from the upper chamber. With the upper chamber at atmospheric pressure, the suction head forces slurry into the lower chamber. Then, when the upper chamber is pressurized, the diaphragm forces the slurry out through the specially designed ball check valves.

Problem Slurries

Yes, slurries *can* be metered accurately. And the best proof of this claim is the thousand or more Milton Roy pumps successfully metering slurries in the field. The list includes such problem liquids as an 80% coal slurry, a 45% suspension of lead peroxide in butyl phthalate, 15 to 20% diatomaceous earth slurries, finely divided nickel catalytic suspensions, gold ore slurries, and even a 55% by weight powdered aluminum suspension. Some of these materials are so thick that they can support the weight of a screwdriver.

If precision metering of slurries is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solutions. Write for a general introduction to controlled volume pumping given in Catalog 553-1, Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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Largely because we, in the United States, still have great reserves of coal, oil, and gas, many people, among them power engineers, have questioned the desirability of spending huge sums of money on the development of nuclear power. Aside from the fact that our fossil fuel reserves are being depleted at a very rapid rate, there are very valid reasons for developing nuclear power as soon as possible.

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This article by the Chief Engineer of the Nuclear Products Division and the Process Engineer of Stone & Webster Engineering Corporation describes a vapor container for a nuclear power plant that is quite different from those heretofore constructed in that it is mounted on 16 equidistant pipe columns.

A Proposal to Assist in Conserving Our Fossil Fuel Resources. By Harry A. Kuljian 54
Mr. Kuljian is a farsighted engineer and an ardent conservationist. In 1954 in POWER ENGINEERING he presented an article entitled, "A Look at the World's Energy Resources". Now, in another article on the same general subject, he discusses our rapidly vanishing fossil fuels and advances a proposal for the more rapid development of nuclear power in the United States.

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WHY NUCLEAR POWER?

IN THE RELATIVELY few years that we have been trying to design and build nuclear power plants we have discovered that the job is not particularly easy. Offhand, the idea is quite simple. A nuclear reactor is a source of heat; since heat will generate steam, the steam can be used to run turbine-generators to produce electric power. The reactor merely takes the place of the conventional steam boiler.

A reactor, however, is far more than a boiler. It is also a source of deadly radiation. Like a furnace it produces heat by burning nuclear fuel but unlike a conventional furnace, the reactor can contain all the fuel it may need for years. And, since nuclear reactions are infinitely more rapid than chemical reactions such as involved in combustion, this great quantity of nuclear fuel constitutes a hazard very different from the hazards attending conventional boiler operation. The power level of a nuclear power reactor can rise from zero to many millions of kilowatts in a very small fraction of a second. Because of all these factors, reactors are very difficult and costly to make.

Why, then, if the job is so difficult and costly, are we trying to develop nuclear power? Why not stick to good old coal and oil and gas and save all the trouble?

There are several reasons. First, and perhaps the best, is that such an attitude would be a defeatist attitude, not consistent with the American spirit of scientific progress. Nuclear energy represents the most concentrated source of power in the universe—it is inevitable that man should develop it for whatever use he may want to make of it, good or bad. If we do not develop it, other countries will, and so nuclear power development becomes a matter of international prestige. We cannot afford not to develop nuclear power.

There is, however, another important reason for developing this new source of energy. Our coal, oil, and gas reserves, may not be as inexhaustible as many have supposed. True, they are still ample but at the increasing rate at which they are being used the time is not far distant when we will have to look for other sources of power. And, of all the alternative sources which have been considered, nuclear energy offers the most promising prospects for early use.

In the following pages, Harry A. Kuljian, President of the Kuljian Corporation, discusses the question of our fossil fuel reserves in considerable detail and at the same time proposes a plan to stimulate interest in the development of nuclear power and thus conserve our remaining fossil fuel reserves for possibly better use than burning them under boilers.

Andrew W. Kramer

The Vapor Container for the Yankee Atomic Electric Plant

The containment vessel for the Yankee Atomic Electric Plant now under construction at Rowe, in the northwest corner of Massachusetts, near the Vermont border is different from previously constructed vessels of this type in that it is supported above ground on pipe columns. At the same time, the internal concrete structure is supported on concrete columns.

By Charles T. Chave
Chief Engineer, Nuclear Products Div.

and O. P. Balestracci
Process Engineer

Stone & Webster Engineering Corporation

THE VAPOR CONTAINER designed for the Yankee Atomic Electric Co. plant at Rowe, Mass., represents an evolution of design ideas from installations previously designed by Stone & Webster and other organizations.

The design of a vapor container depends on the "maximum credible accident" postulated for the nuclear plant. It must be shown that the vapor container can withstand the effects of the accident without releasing its contents to the atmosphere.

Factors taken into consideration in designing the vapor container for the Yankee Atomic plant included:

Economics of the pressure-volume relationship;

Size required for enclosure of equipment;

Type and configuration of the containment system;

Optimum materials of construction;

Requirements of national and local pressure vessel codes;

Biological shielding, both for normal operation and for emergency conditions;

Protection of the shell from damage by potential missiles of maximum size and velocity;

Installation of the container above or below ground;

Leakage limits and leakage testing procedures;

Corrosion protection for internal and external shell surfaces; and

Type of fuel handling system required.

Design of the Yankee Atomic vapor container was based on the experience of Stone & Webster Engineering Corp with the detail design of a number of containers for proposed and actual projects. These included the containers for the Pressurized Water Reactor plant at Shippingport, Pa., for Westinghouse Electric Corp and the Army Package Power Reactor plant at Fort Belvoir, Va., for Alco Products., Inc.

New Concepts Formulated

The PWR and the APPR plants were pioneering projects for which new concepts had to be formulated, modified and put into practice to solve the problem of vapor containment.

The ideas evolved during the design and construction stages of these projects have been used in designing vapor containers for other plants.

Few rules can be given for standardizing the design of containment systems. Vapor containers designed by Stone & Webster for three major plants were each of a different type. A group of interconnected horizontal cylinders was used for the PWR, a vertical cylinder for the APPR and a sphere for the Yankee Atomic Reactor. In each case, the container was of special design to suit plant characteristics or imposed criteria.

In the case of Yankee, a spherical container was selected, since it is more economical than an upright cylinder for a large plant. Elevation of the container above grade made it possible to avoid excavation costs and expensive construction methods.

A mechanical lift is used to handle fuel between the elevated container and a fuel pit having a minimum submergence below grade. Shielding and missile protection are provided by a detached concrete structure rather than by a concrete lining, which would have been expensive to install in a spherical container.

Calculations showed it unnecessary to provide an external shadow shield for protection of the public in the event of a nuclear incident. Minimizing of external shielding requirements contributes further to the practicality of a spherical vapor container.

Fig. 1. The concrete reactor structure under construction. At left, A. Sasembrock, resident engineer, Stone & Webster. Right, Frederik D. Kenison, resident engineer, Yankee Atomic Electric Co.

Figure 2 shows the container in plan and elevation. Note the separate supports for the concrete structure.

Evolved Through Stages

The final design of the Yankee plant container evolved through several stages. The first design considered was a single horizontal buried steel cylinder with hemispherical ends, lined with concrete 2 ft thick. The reactor and shield tank were to be located at the center of the container. Two horizontal steam generators were to be placed at either side of the reactor and separated from it by concrete partitions. Design of lining and supports for the container would have been difficult. Placement of equipment in the container would have involved a formidable craneway structure extending over the top of the shell, so apparatus could be lowered through a manhole. These difficulties and the excessive estimated cost of the design concept led to its abandonment.

The second concept was a group of three above grade vertical cylindrical shells with hemispherical heads. The reactor was to be located in the central container and each of the other containers was to house two steam generators separated by concrete walls. While this arrangement was considered cheaper than a single buried cylinder, it did not eliminate certain disadvantages.

Handling of equipment within the containers would have required a craneway above the top heads, or other expensive means. Either concrete linings or detached internal concrete structures with a shadow shield completely around the three containers would still have been necessary. An additional problem was the maintenance of rigid support while allowing lateral expansion of three vessels having common openings.

From cylinders, the thinking turned to spheres. Interconnection proved difficult for a group of three vertical spheres, and further study led to the more practical concept of a single sphere.

Advantages found for a single spherical container included lower fabrication costs, easier analysis of stresses at discontinuities and penetrations, and the possibility of using a crane to handle all large equipment within the container. Moreover, space was available for installation of individually shielded compartments for four loops arranged radially. The individual compartments would limit the extent of an accident and would allow maintenance work or repair operations to be carried out on a shutdown loop while the other loops were operating.

In its first design, the sphere was supported by a short conical skirt, and equipment was handled through a top opening by means of an expensive crane arrangement. The design was greatly improved by elevating the entire container and placing the equipment access hatch on the underside of the container so that equipment could be handled by an internal polar crane from a railroad track below the sphere. The conical support for the container shell would have given superior stress distribution, but this design was abandoned in favor of columnar supports spaced around the equator when it was found that no fabricator could handle economically the course of beveled thick plate required at the junction of the skirt and shell.

Early designs for the support of the internal concrete structures led to pinning down the container shell by carrying the weight through the steel. This was remedied by a new design in which the internal structures are carried on independent steel-encased supports provided with expansion joints to permit the container shell to expand yet maintain a gastight seal.

Another variation studied was a single 115 ft diameter horizontal aboveground steel cylinder with hemispherical ends. Equipment would have been handled from a railroad car entering one end of the cylinder on a swing bridge leading from a ramped track. A knockdown shield tank design would have been needed to allow handling of equipment within the container by a traveling crane. Although this concept was estimated to cost little more than a spherical container, it was considered less practicable.

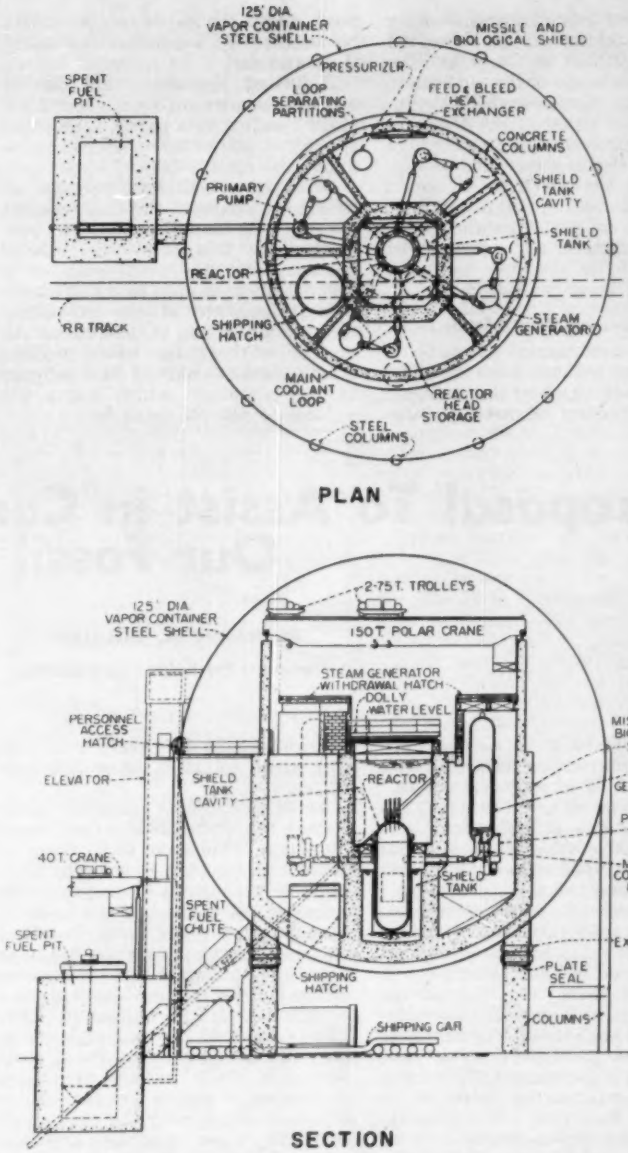

Fig. 2. Plan and sectional view of the Yankee vapor container

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The present design for the vapor container consists of an elevated steel sphere 125 ft in diameter. The minimum thickness of the shell plate is ¾ in. The container shell is supported at its equator by 16 equidistant pipe columns. The weight of the concrete structures and equipment within the container is carried on eight reinforced concrete columns, six arranged at equal distances in a 73 ft-6 in. diameter circle and two at the center of the container where the highest load is concentrated.

All Pressurized Parts Enclosed

An equipment access hatch is located near the bottom of the container shell. A spur track under the container allows positioning of heavy equipment under the hatch so that it can be handled by a polar crane within the container.

Refueling operations are carried out by using an inclined water filled chute connecting a partly submerged spent fuel pit with the flooded space above the reactor core.

The vapor container encloses all pressurized parts of the main coolant system. The maximum accident postulated for this plant was loss of coolant from the open ends of a severed main coolant line and simultaneous rupture of one secondary steam main within the container. An accident of this nature would produce a maximum pressure of 34.5 psi gage in the container, which has a net volume of 840,000 cubic feet.

The ductile austenitic stainless steel used for the main coolant system and the stainless-clad carbon steel reactor vessel are not considered feasible sources of missiles. Nevertheless, missile protection is afforded by the concrete structures surrounding the reactor and main coolant system. The bolting down of components to prevent them from becoming missiles, as was done for APPR-1, is not practicable for the large reactors and steam generators at the Yankee plant.

The finished container will be tested at 1¼ times the working pressure. Leakage detection tests to be made at the test pressure include a bubble test, a halogen gas tracer test at all welded seams and a pressure reduction test.

A Proposal To Assist in Conserving Our Fossil Fuel Resources

By HARRY A. KULJIAN

President, The Kuljian Corporation

IN MARCH 1954 the author published an article entitled "A Look at the World's Energy Resources" which was in effect a warning to enlighten people of the world that ways of using fissionable material must be developed as soon as possible so that our coal, oil and gas resources can be conserved. Many factors influence our accelerated use of energy resources including growth of population, increased mechanization, better standard of living, etc. One of the primary factors is growth of population. Under the stimulus of advances in sanitation and medicine we have experienced a decrease in death rates but no compensating decrease in birth rates. As a result the population of the world is sky-rocketing.

Data assembled by the United Nations indicates the world's population during comparatively recent years to have been as follows:

In 1920	1,810 million
In 1930	2,013 million
In 1940	2,246 million
In 1950	2,476 million
In 1956	2,734 million

The world's population at present, according to United Nations estimates, is increasing approximately 44,000,000 a year and the rate of increase is still accelerating.

Looking at this situation from another angle, and using the year 1000 as a base, the world's population doubled by around 1650, or within 650 years, doubled again by about 1870, or within 220 years, and doubled again by 1950, or within only 80 years.

As an example of changing conditions in the United States the Census Bureau in 1940 gave eight series of population forecasts to the year 1975. The one considered most reasonable indicated 160 million people in 1975. Apparently no one even imagined that our present population would be close to 175 million. Current estimates of the Bureau of the Census show a population of 244 million in 1980. This is about 53 per cent higher than the estimate made by the Census Bureau in 1946. Past and predicated population is shown for the United States in Fig. 1 with the predictions until 1980 based upon data and forecasts of the U. S. Bureau of the Census. After 1980 a trend towards saturation has been indicated as considered by Palmer Putnam's population growth analysis and forecast (Energy in the Future, page 70).

Coupled with this phenomena of growth in population is the constantly increasing annual kilowatt hour usage per capita. For example, the use per capita in 1940 was *1350* kwh, in 1950, *2580* kilowatt hours, in 1957–*4160* kwh, and is predicted in 1980 to amount to *7360* kwh.

The combination of the various influencing factors has resulted in expanding uses of electrical energy at an annual compounded rate approximately 3 times the rate at which our population growth is compounding. The total electrical energy production in the United States expanded from 388,674 million kwh in 1950 to 715,705 million kwh in 1957. The Federal Power Commission estimates that 1,900,000 million kwh will be required in the year 1980, a figure three times present requirements.

The increase in total annual energy demand in the United States as well as the Btu fuel requirement to produce this energy are shown in Fig. 2. The Btu requirement has been calculated upon a steadily decreasing Btu per kwh ratio by virtue of increased efficiency as indicated in Fig. 3 which was derived from the "Report on Nuclear Energy and the U. S. Fuel Economy 1955–1980" by D. Teitelbaum. To indicate the exploding tempo of energy requirements, it is interesting to note that the estimate for 1980, made in 1958, is 15 per cent greater than the estimate the same organization made only four years previously and now, only a few months later, it indicates that the next estimate, due this year, will probably be 5 per cent higher or about two trillion kwh for 1980.

To supply these energy requirements, with an allowance of 15 per cent for reserves, it is predicted that the U. S. National total installed capacity by the end of 1980 will be 420 million kw as compared to the 145,689,000 kw at the end of 1957. Of this total it is estimated that about 58 million kilowatts will be hydroelectric, leaving a total in fuel burning capacity of 362 million kw. Considering energy production the hydroelectric capacity is expected to produce only about 12 per cent or 250 billion kwh per yr.

The contribution of hydroelectric generation in the total electric energy generation is shown in Fig. 4. The prediction for 1980 is based on the "Report on Nuclear Energy and the

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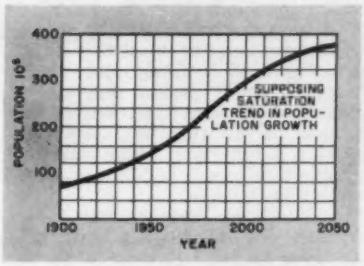

Fig. 1. Population growth in the U. S.

U. S. Fuel Economy 1955–1980" by D. Teitelbaum. The forecast for later years shows a natural saturation, approaching asymptotically the 500 x 10^9 kwh per yr line, representing the maximum potential water power determined by geographical conditions. (Geological Survey Circular 367, Department of the Interior, Developed and Potential Water Power of the U. S. and other Countries, Dec. 1954.) The graph also shows the fuel heat equivalent that can be substituted for annually by the hydroelectric power generation on the basis of Fig. 3.

The United States is blessed with a large, but certainly not an inexhaustible amount of fossil fuels; particularly with respect to oil and gas it is none too soon to give consideration to conserving our remaining resources for uses other than burning in furnaces for the production of electrical energy, i.e., as a raw material in the chemical industry. With the presently expanding use for oil and gas fuels it is not improbable that virtual exhaustion could be anticipated within 25 years.

The United States Bureau of Mines estimates of the amount of our fossil fuel recoverable reserves, as shown in Table I.

As shown in the table, large quantities of oil shale are available in the United States which the petroleum industry recognizes as a wholly feasible source of liquid fuels. More than 500 billion bbl [1] of oil is contained in shale of a richness of 10 to 50 gal per ton. More than 100 billion bbl of this oil is already considered to be economically recoverable. This recoverable portion is equivalent to 0.630 x 10^{15} Btu.

The depletion of the reserves of fossil fuels is not caused by generation of electricity alone; in fact, a surprisingly small part of the fuel consumption goes into electrical energy. The requirement for electric power generation in the total fuel demand is shown in Fig. 5. The forecast for 1980 is again taken from the "Report on Nuclear Energy and the U. S.

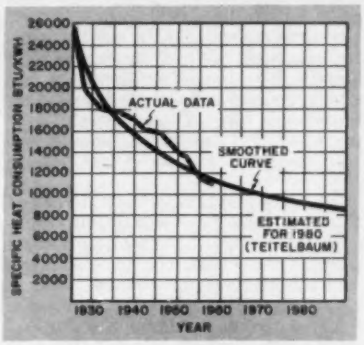

Fig. 3. U. S. central station heat rates. Weighted average projected to 1980. Btu per kwh

Fuel Economy 1955–1980" by D. Teitelbaum. The trend of the heat demand for electrical energy seems to level off at about 20–22 percent of the total heat consumption. The other main fuel consumers are motor cars, railroad and airplane transportation, heating and cooking in the home, building and industrial establishment heating or other industrial uses.

How the different sectors have shared in the total heat consumption and the predicted trend until 1980 is shown in Fig. 6. Naturally, further extrapolation of the total heat demand curve is uncertain. Figure 7 shows the per capita heat demand derived from Figs. 1 and 6. The variation in predictions shown for the far future is responsible for the two very different curves in Fig. 7. Palmer Putnam in "Energy for the Future" predicts a steady 2 percent yearly increase in per capita heat demand as dominating the foreseeable future. On the other hand it is logical to assume that the natural trend of saturation will result in a certain leveling off of this curve. No one can foretell, however, when this saturation trend will begin to act and the point at which it will level off. The saturation trend curve shown in Fig. 7 is at best only a guess.

Using both the curves in Fig. 7 we are now in a position to extrapolate further the energy demand curves and to summarize the annual heat requirements in an attempt to answer the question: "How long will our fuel reserves be able to supply the demands?" Fig. 8 is the result with curves based upon a steady 2 percent annual increase in per capita heat demand and also on an arbitrary saturation trend.

The U. S. Geological Survey in its publication, "Coal Resources of the United States" October 1, 1953, after carefully explaining the many indeterminate factors in predicting the life of our fuel reserves makes the following statements:

"Similarly, measured and indicated coal reserves in beds 28 in. or more thick and less than 2000 ft below the surface are 320 times the average annual production during the period, 1940 to 1949; whereas the proved reserves of petroleum are only 18 times the average annual production, and the proved reserves of natural gas are only 40 times the average annual production.

"In analyzing the life expectancy of the U. S. fuel reserve, Ayres and Scarlott (1950, p. 162) conclude that the mineral fuels alone can supply our future needs for a short period of 75 to 250 years.

"Ultimately, ..., population growth must level off, and other sources of energy must be made available if we are to continue the comfortable standard of living now enjoyed through use of the mineral fuels."

Figure 9, derived from previous graphs, shows inverted integral curves of heat demand against the different fossil fuels, thus indicating the pos-

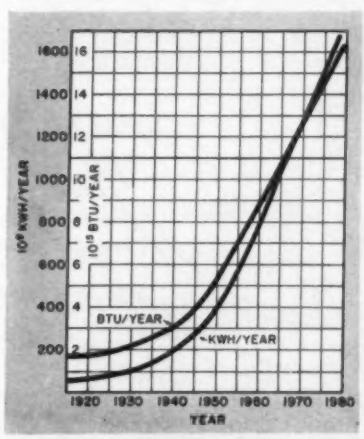

Fig. 2. Annual U. S. power production projected to 1980. Kwh produced per year. Btu consumed per year

[1] Peaceful Uses of Atomic Energy, Volume 2, January 1956, Joint Committee Report, 84th Congress, 2nd Session.

Table I

	Quantity	BTU Content
Coal (1953 estimates)		
Anthracite	12 x 10^9 tons	.305 x 10^{15}
Bituminous	500 x 10^9 tons	13.1 x 10^{15}
Semi-bituminous	185 x 10^9 tons	4.07 x 10^{15}
Lignite	230 x 10^9 tons	3.772 x 10^{15}
Sub-total coal	977 x 10^9 tons	21.247 x 10^{15}
Oil (1957 estimate)	303 x 10^9 bbls.	0.176 x 10^{15}
Oil Shale	500 x 10^9 bbls.	.630 x 10^{15}
Gas (1956 estimate)	cu. ft.	0.232 x 10^{12}
		22.309 x 10^{15}

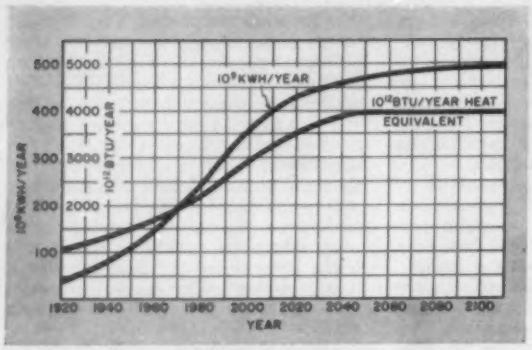

Fig. 4. Annual hydro power production projected to 1980. Kwh generated per year. Equivalent thermal station heat consumption. Btu at weighted average heat rate

sible decline and ultimate exhaustion of such fuels. The resulting spread of exhaustion from 100 to 150 yr falls midway in the wider year range prediction of 75 to 250 yr cited above.

Under present trends the United States is committing itself more and more to a liquid — and gaseous — fuel economy. Ultimately coal may become an important material for synthesis of these fuels in addition to filling the requirement for solid fuel. If and when such conversion of coal becomes general, the need for coal will be enormous for, on the basis of present technology, about 50 percent of the potential energy in coal is lost in the conversion to liquid fuel.[2]

Other sources of energy of which we now have some knowledge include solar energy, tidal power, wind power,

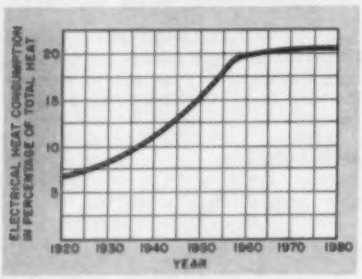

Fig. 5. Heat consumption of electrical power production in per cent of total heat consumption

geothermal power and power from nuclear fission. Our present technical knowledge indicates the power from nuclear fission is most promising of these for early energy production in the magnitude required.

The two elements now affording possibilities for use as nuclear fuel are uranium and thorium. The actual reserves of these two metals is rather indefinite at present but obviously are the equivalent of many times our fossil fuel reserves.

[2] Geological Survey Circular 293 Coal Resources of the United States, October 1, 1953, page 162.

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In view of the preponderance of fissionable materials which could be used for the peaceful generation of electrical energy and the comparative low reserves, of fossil fuels now used largely for that same purpose but which could be conserved for other important uses *it would only seem provident that our nation should abet and encourage nuclear power generation.*

The present important deterrent to atomic energy power production is cost. All electric utilities hold an important responsibility to customers and stockholders or owners. Cost of electrical energy influences industrial expansion and standards of living and so in effect creates a competitive condition between cities, states and areas of these United States. Deliberate embarkation on power developments known in advance to be greater in cost than some other type is difficult if not impossible for most utilities. Government subsidy through the Atomic Energy Commission is being given to a very limited extent. This effort however is so small that the effect on conservation of fossil fuels is infinitesimal.

Regarding construction costs under present technology the primary difference between conventional steam plants and nuclear plants lies between boilers and reactors. The cost of a reactor is perhaps 2½ to 3 times that of a comparable boiler. The balance of a thermal power plant is essentially the same in construction and cost regardless of whether boilers or reactors are used.

Again fuel costs appear to be about the same if fossil fuel costs are assumed as being in the range of 30 to 35 cents per million Btu.[3]

Net power costs of 13 to 16.5 mills per kwh have been projected for four plants in the Power Demonstration Reactor Program of the AEC. These plants are expected to be in operation by 1960–62. With continued technical progress, it seems reasonable to assume generating costs of nuclear plants may be reduced to about 12 mills per kwh by 1965.[3]

These nuclear power costs compare with a net cost of from 7.5 to 8.5 mills per kwh in modern fossil fuel plants where fuel costs are about 30 to 35 cents per million Btu. The difference of at least four mills per kwh is that which must be overcome if utilities are to be induced to freely and wholeheartedly enter into a program of nuclear power plant construction. The national benefit which would arise out of such a program would seem to dictate that means be found to overcome this obstacle.

[3] Productive Uses of Nuclear Energy. National Planning Association. Pages 51 and 52.

Unless some unsuspected major advance in nuclear power technology is made in the near future the only early approach to the use of nuclear fuels in any magnitude would seem to depend upon government subsidy in some form. Considering various possibilities such as outright cash subsidy for construction purposes or tax relief on an annual basis it appears that the one holding best possibilities is the furnishing by the Government of nuclear fuels at costs low enough to overcome the advantage held by fossil fuels.

Fossil fuels presently hold the advantage in one major category only — construction cost. To an operating utility this is reflected in net costs of energy production by greater interest burden, depreciation or amortization, taxes and insurance. Operating labor, replacements, supplies and fuel costs, in the area of about 30 cents per million Btu for fossil fuels, do not appear to be greatly different. The problem therefore is to overcome the difference in cost per kilowatt hour attributable to the greater cost involved in construction.

The production of nuclear fuel is solely in the hands of the Federal Government at present and for the foreseeable future is expected to so continue. Its sale and use can therefore be entirely at the discretion of the Government. This permits its disposal under such terms, conditions and prices as may be considered to be in the greatest national interest.

It seems essential, therefore, that the Federal Government should give immediate consideration to the establishment of a formula for determining the price for nuclear fuel at a level which

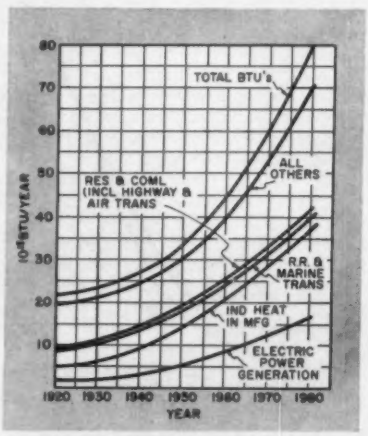


Fig. 6. Yearly heat consumption classified by use

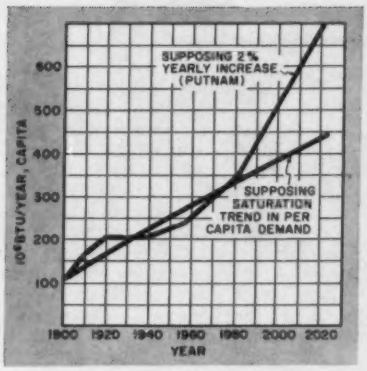


Fig. 7. Increase in yearly per capita heat demand

will permit generation of electricity on a competitive basis with fossil fuels.

This does not mean that any incentive should be offered which would call for consideration of nuclear plants in low cost coal areas. As far as coal is concerned, at least in initial stages, only areas of above average coal costs should be considered. But since the immediate objective is to conserve our oil and gas resources, which are in the most danger of relatively early exhaustion, urgent consideration should be given to their replacement to the maximum extent possible.

The idea of achieving comparable generating costs through manipulation of nuclear fuel prices has the added advantage that it can be applied to both public and private enterprises on equal terms. This should permit its acceptance by adherents of both philosophies without political repercussions.

Also the government under any such undertaking should insist as a firm requirement in connection with the supply of nuclear fuel that its use be especially encouraged in breeder type reactors. Otherwise only a small percentage of the energy contained in uranium is used and the comparatively rare U_{235}, essential to the breeding process, would itself be subject to more rapid exhaustion.

In effort to determine the magnitude of the differential between electrical energy produced from nuclear and fossil fuels an example follows for a plant consisting of one 100,000 kw unit. The boiler side of an average coal burning plant generally represents about 44 per cent of the total cost. The AEC in its 1957 publication "Atomic Energy Facts" indicated that reactor costs are about in the ratio of 2.55 to 1 as compared to boilers but that no difference in costs are anticipated in the balance of the plant. This leads to the conclusion that a reactor plant would cost about 1.57 times the cost of a coal plant. Since recent developments have indicated that reactors are costing more than anticipated, the ratio for the purpose of this demonstration is arbitrarily raised to 1.67. The analysis is shown in Table II.

Table II

Plant Cost for 100 MW Unit	Coal Plant $15,000,000	Nuclear Plant $25,000,000
Annual Fixed Charges Involved in Power Generation		
Interest 4 percent	$600,000	$1,000,000
Depreciation 4 percent	600,000	1,000,000
Property taxes & Insurance 1 percent	150,000	250,000
TOTAL	$1,350,000	$2,250,000

The resulting difference in annual cost of $900,000 results in the following difference per kilowatt hour produced for various load factors:

50% = 2.06 mills
60% = 1.71 mills
70% = 1.47 mills
80% = 1.28 mills
90% = 1.14 mills
100% = 1.03 mills

If a price for atomic fuel of 40 cents per million Btu is assumed, it would be about the equivalent of 12,000 Btu per pound coal at $10 per ton. Coal at this price for 100 per cent load factor operation would cost $4,204,000 per year. If the costs are just to be equalized for an atomic power plant then the atomic fuel must cost $900,000 less or only $3,304,000.

At other load factors the kilowatt hour allowances required to be competitive would be in the order indicated in Table II. However, an allowance in nuclear fuel costs which would simply create a break-even situation is probably insufficient to provide an incentive for utilities to make the greater investment. An additional allowance should be made in such magnitude that it would add sufficient incentive to greatly accelerate the construction of atomic power plants and thus achieve the objective of conserving fossil fuels.

In view of the AEC's Ad Hoc Committee's recently announced aim to fortify the position of leadership of the U. S. in the technology of nuclear power for civilian use, it seems that some sort of incremental subsidy such as described here should be put into effect as soon as possible. Willis Gale of Commonwealth Edison also has advanced a similar recommendation under which the AEC would put up the difference in construction cost and/or operating costs of a nuclear plant over a conventional station. As far as technical know-how is concerned all the essential data and information relating to civilian nuclear technology has now been declassified and such an incremental subsidy as proposed here might encourage many of the smaller companies in this country to engage in nuclear work. There are many small firms in the United States with skilled engineering personnel, which if given the opportunity, could contribute in their own branch of the profession, to the further advancement of nuclear power technology. Many of these small firsm already hold Access Permits. They have had many years of practical experience in the design of conventional power plants and this accumulated reservoir of experience might prove of great value in overcoming the remaining problems in the nuclear field. THE END

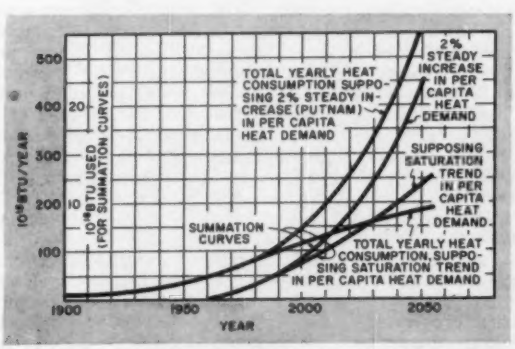

TOTAL YEARLY HEAT CONSUMPTION SUPPOSING 2% STEADY INCREASE (PUTNAM) IN PER CAPITA HEAT DEMAND
2% STEADY INCREASE IN PER CAPITA HEAT DEMAND
SUPPOSING SATURATION TREND IN PER CAPITA HEAT DEMAND
SUMMATION CURVES
TOTAL YEARLY HEAT CONSUMPTION, SUPPOSING SATURATION TREND IN PER CAPITA HEAT DEMAND
10¹⁵ BTU/YEAR
10¹⁵ BTU USED (FOR SUMMATION CURVES)
YEAR

Fig. 8. Total Annual Energy demand, summation curves

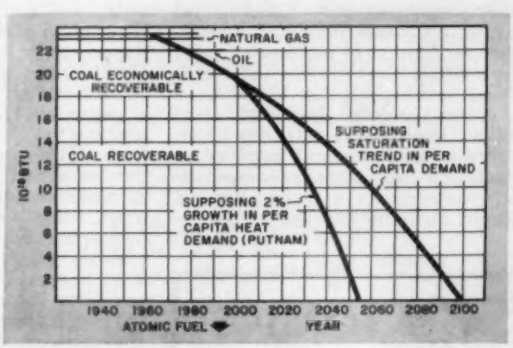


Fig. 9. Decline of national fuel reserves

New Nuclear Literature

Nuclear Engineering Handbook. First Edition. Prepared by a staff of specialists with Harold Etherington as Editor-in-Chief. 6½ by 9¼ in. 1872 pages. Published by McGraw-Hill Book Co, Inc, 330 West 42nd St, New York, N. Y., 1958. Price $25.00.

Of all the books on the subject of nuclear science published to date, this new handbook on nuclear engineering is without question the most comprehensive. It's almost 1900 pages cover virtually every aspect of nuclear engineering from basic mathematics and nuclear physics to the mechanical design and the operation of reactors, on a practical level useful to engineers interested in industrial and other applications of nuclear energy.

Seventy contributors, each a specialist in his particular area, contributed sections on their specialties in nuclear science and technology, theory, and practice, with special emphasis on reactor engineering. Under Harold Etherington's editorship, the resulting handbook strikes a balance between a strict compilation of data and a cyclopedia of nuclear engineering. As he points out in the preface, the book was prepared to satisfy a pressing need for an authoritative single-volume compilation of nuclear information and data. The result is an excellent job and the volume should satisfy the needs of a wide variety of people interested in this new and growing field — engineers, scientists, students, research workers, technical writers, etc. It presents the basic data used in all phases of nuclear engineering. Science and technology, and theory and practice are thoroughly covered, and, as already indicated, special emphasis is given to reactor engineering. Reactor designers will be particularly interested in the sections on reactor physics, radioactivity, shielding, fluid flow, and heat transfer. Formulas, comprehensive tables, and methods of calculation make this material especially useful. Another feature of the section on reactor physics, is the detailed treatment given to reactor calculations by J. R. Dietrich. Beginning with a basic explanation of the fission reaction and fundamental neutron processes, involving quantitative specification of interaction rates and neutron cross section the methods of making reactor calculations are covered in detail. Included in this section are sample calculations which illustrate the procedures involved in calculating the material constants and reactivity for a typical lumped reactor. Since the purpose of the example is to illustrate procedures rather than to arrive at very accurate results, the numbers involved are carried out to only slide-rule accuracy.

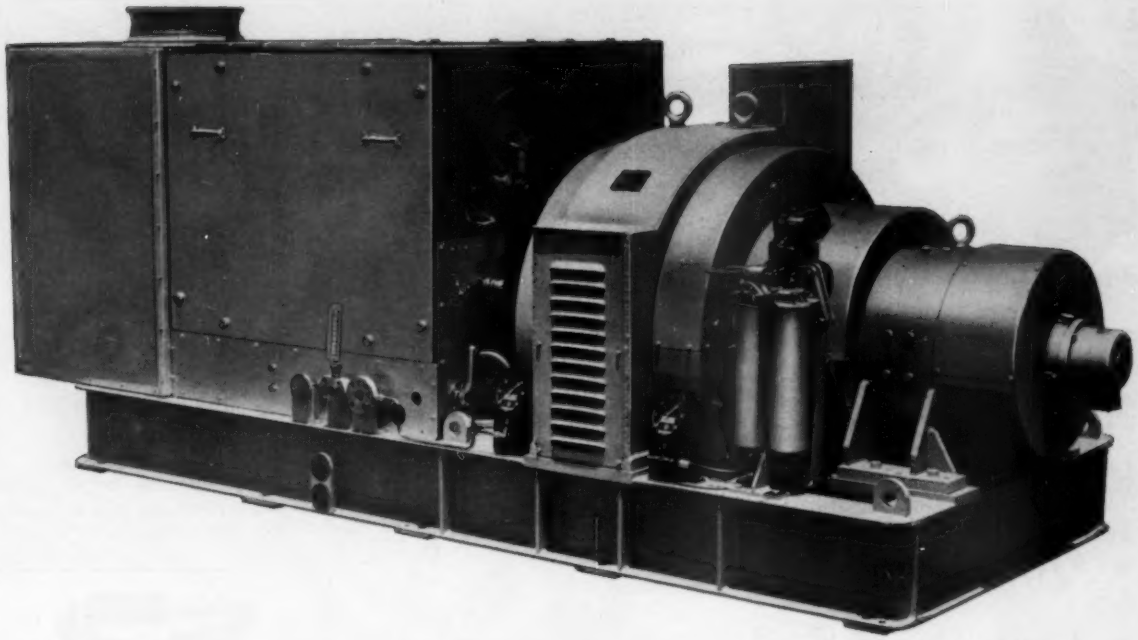
The handbook is divided into 14 major sections as follows: I. Mathematical Data and General Tables; 2. Nuclear Data; 3. Mathematics; 4. Nuclear Physics; 5. Experimental Techniques; 6. Reactor Physics; 7. Radiation and Radiological Protection; 8. Control of Reactors; 9. Fluid and Heat Flow; 10. Reactor Materials; 11. Chemistry and Chemical Engineering; 12. Nuclear Power Plant Selection; 13. Mechanical Design and Operation of Reactors; 14. Isotopes.

A useful feature of the handbook is the Guide to Tabulated Data in the first section of the book. Two methods are available for finding the data and formulas — the index at the back of the book and the set of tables just mentioned. These guide tables indicate the contents of the most frequently used tables and, by showing contextual material, provide guidance that may be inherently difficult to give in an index. Judicious use of both the index and the guide tables is recommended. The guide tables in Section I are followed by articles summarizing frequently used data and formulas, and giving references to pertinent sections of the handbook.

One has to see and examine this book to appreciate the immense amount of useful material it contains. All the subjects in the 14 major divisions of this volume have, of course, been covered in various degrees of detail in other separate books but to have them all included between the covers of a single book is a welcome convenience.

* * *

Among the recent publications issued by the Technical Information Service Extension of the AEC, at Oak Ridge, Tennessee, is TID-7558 entitled *Controlled Thermonuclear Reactions.* This 528-page, 8 by 10½ inch volume contains all the papers presented at the Controlled Thermonuclear Conference held in Washington, D. C., February 3 to 5, 1958. It is without doubt the most complete description of the work that has been done both in the United States and Great Britain in this field of research, to be found anywhere. It begins with a paper by Lyman Spitzer, Jr, describing the status of Project Matterhorn. This project, which is being carried out at Princeton University, is directed toward two main goals. First, there is the practical objective of heating a plasma to the highest possible temperature and confining it by means of a magnetic field. This is clearly the central purpose of the Princeton thermonuclear program at the present time, and must be achieved if a thermonuclear reactor is to be possible. Secondly, there is the scientific objective of understanding the complex phenomena which occur in a fully ionized gas. The work at Princeton involves the Stellarator. Spitzer's paper is followed by an account, by P. R. Bell, of the work under way at Oak Ridge, involving the Oak Ridge DCX magnetic mirror machine. The operation of this machine which was also described in detail at the Geneva Conference last September, is based on the injection of high energy ions into an electric arc. These two papers are followed by descriptions of the British ZETA, the Sherwood Program at Los Alamos, and the Research at the Associated Electrical Industries Laboratories at Aldermaston in England. . . . The Columbus S-4 experiments at Los Alamos are described by Burkhardt and Lovberg. . . . There are papers on the Static Pinch, the Triax Pinch Device, The Dynamic Screw Pinch, the Felix Experiment, the Toy Top Experiment, electron energy distribution, dissociation of hydrogen and deuterium ions by the carbon arc, experiments with cyclotron resonance, and hydrogen discharges in the B3 Stellarator. . . . Among the papers delivered at the session on Material Problems, Vacuum, and Shock, are papers on the acceleration of plasma into vacuum, radiation damage effects in thermonuclear reactors, metal vapor pumping, sputtering of copper by ions of various energies, and the performance of the carbon arc as an ion pump. . . . Still another group of papers cover general theoretical consideration — dissociation of the hydrogen molecule ion by electron impact, hydromagnetic instabilities caused by runaway electrons, interchange instability by the Boltzman equation, the theory of cyclotron resonance heating, end losses from Pyrotrons, etc. . . . Finally, there is a group of papers covering Diagnostics and Instrumentation. These include such topics as, neutral beams, the Astron pulsed electron gun, diagnostic techniques in the use of ZETA, a multi-channel interferometer, improved feedback integrators, magnetic field design of mirror coils, super fast pinch assembly, ion beam entry calculations, microwave diagnostics of low pressure plasmas. . . . The foregoing list is by no means complete but it will serve to give one an idea of the scope of this book. Unlike Amasa Bishop's book on the Sherwood Project, reviewed in these pages in December, this is not a book for the layman. It is a book for the engineer or scientist seriously interested in all the various techniques of thermonuclear research. The book is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. The price is $4.75.



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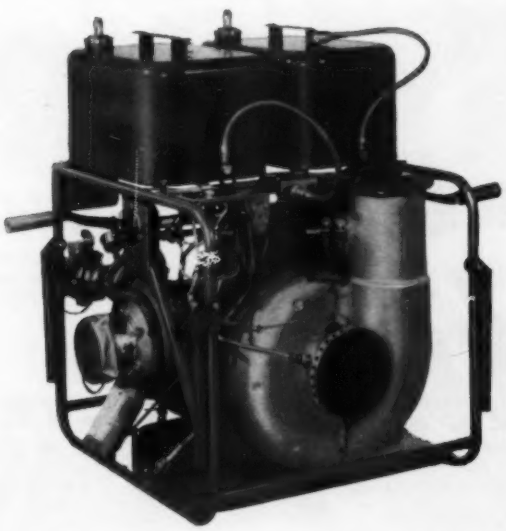

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POWERED BY a 500 hp Jupiter® gas turbine, Solar's 300-kw generator (above) weighs only 6900 lb and is considerably smaller than the average automobile. Solar's 50 hp Mars® gas turbine-powered pump (left) delivers 500 gallons of water per minute—as much as a good-sized fire engine—yet can be carried easily by two men. For more information about these and other Solar gas turbines, write to Dept. F-137, Solar Aircraft Company, San Diego 12, California.

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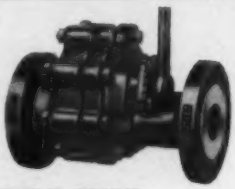

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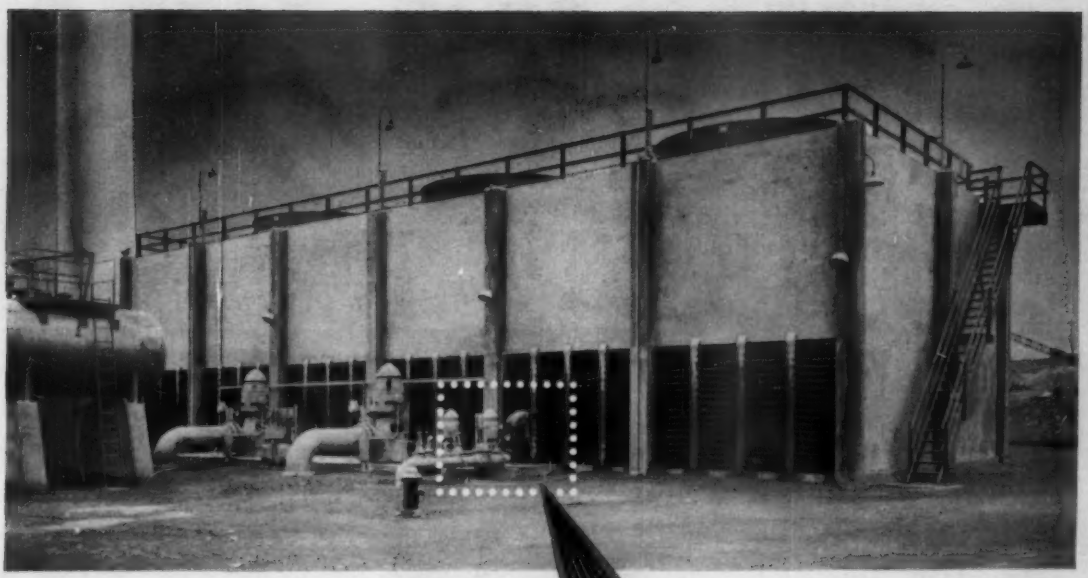
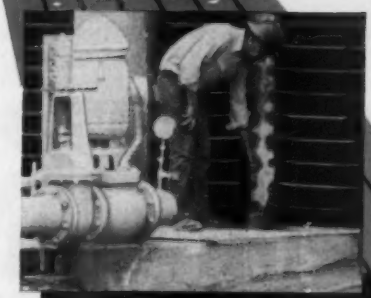


Unusual Cooling Tower gets proven *Nalco* protection

This unusual cooling tower was built for the Riverside Cement Company at Oro Grande, California. The advanced design provides for concrete exterior walls which support and enclose fan units and redwood interior cooling vanes . . . The entire "working sections" of the tower can be repaired or replaced without affecting the structural strength of the shell. Nalco System Treatment protects this cooling system against scale and corrosion — has protected it effectively since it was first put in operation over two years ago. You can get the same complete water treatment protection, promptly, from Nalco. Write for details.



Method of feeding Nalco stabilizing treatment to this system is simplicity itself. Formula is supplied in ball form. Once each shift a perforated tube suspended in the tower basin is filled with balls which slowly dissolve in the cooling water.

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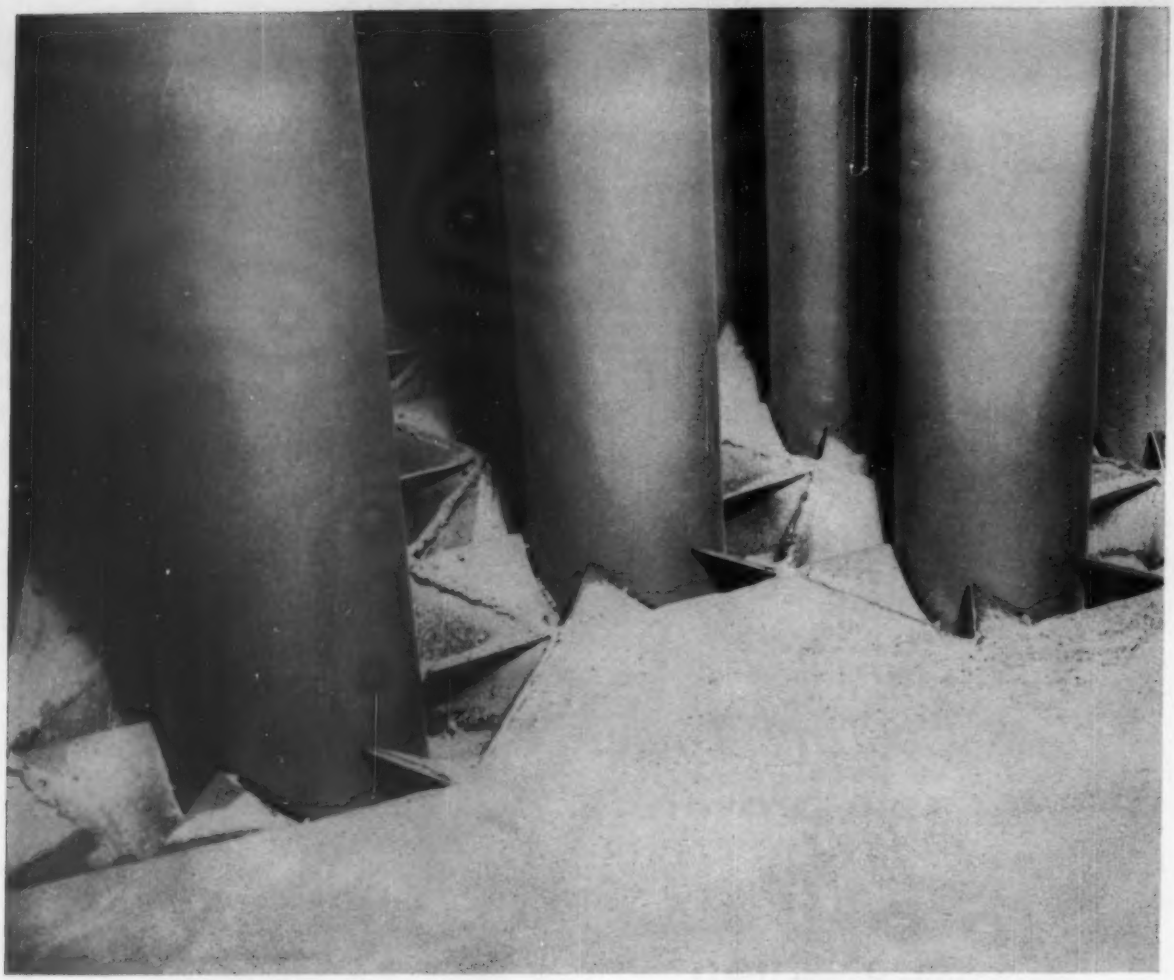

Hagan Dust Collector gets approximately 20 years use in 14 months

NO MAINTENANCE NEEDED

Two 18-tube Hagan Aerostatic Dust Collectors have passed an unusual endurance test at the Rivesville, West Virginia, station of the Monongahela Power Company. Backing up primary collectors, which expel cleaned gas and pass on the fly ash concentrated into approximately 5% of the total gas volume, the Hagan units are handling a dust loading of approximately 40 grains/cubic foot. *This is about twenty times the usual fly ash loading from a wet bottom boiler.* More than 10 tons are collected daily by each unit, which means that a total of more than 2,500 tons of fly ash are collected each year.

The collectors were inspected at the end of fourteen months. Wear was so slight that *no maintenance was needed!* Plant personnel are pleased, since previously used cyclones needed extensive maintenance approximately every year.

Performance such as this is expected of the Hagan Aerostatic Dust Collector. The inlet vanes are designed to act as a venturi, accelerating the incoming air stream on a six-to-one basis. Heavier dust particles with more inertia are accelerated the least, and the lighter, less abrasive particles the most. This is the exclusive Hagan principle of *Selective Particle Acceleration*, the reason for this unit's resistance to tube erosion. The Aerostatic is low in first cost, low in maintenance cost and extremely efficient. Write or phone for details on this money saving, high efficiency dust collector. Ask for Bulletin MSP-124-A.

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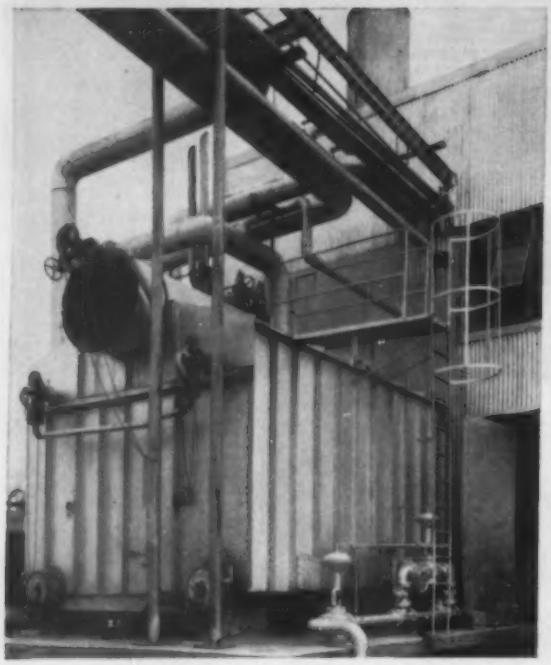
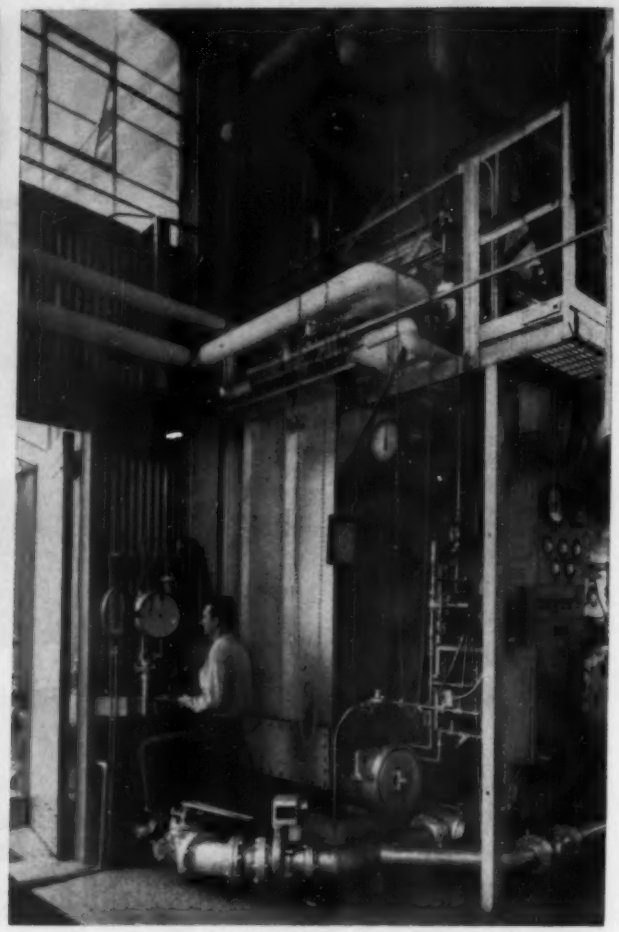
Processing wallboard at Kaiser Gypsum





Union Packaged Boiler takes increased load in stride

A good part of the steam for processing gypsum wallboard at Kaiser Gypsum Company's Long Beach plant is supplied by the 35,000 lb./hr. Union Type MH Packaged Boiler shown.

Semi-automatic fired with a normal operating pressure of 200 psi, this compact unit went on the job in 1956. Installed outdoors, it eliminated the need for further extension of the existing boiler house.

Although originally furnished to deliver steam for 2 out of 5 zones in a Coe Dryer, the MH was later hooked up to carry more of the load handled by an older boiler. Says the engineer-constructor, Kaiser Engineers: "The extra load demand on the Union Boiler was hardly noticeable from an operating standpoint."

Throughout industry, similar reports verify reliable Union performance on stiff assignments. Job-proved designs, complete shop assembly, compactness, easy installation and above average efficiency combine to make Union MH Steam Generators the best dollar-for-dollar buy on the market.

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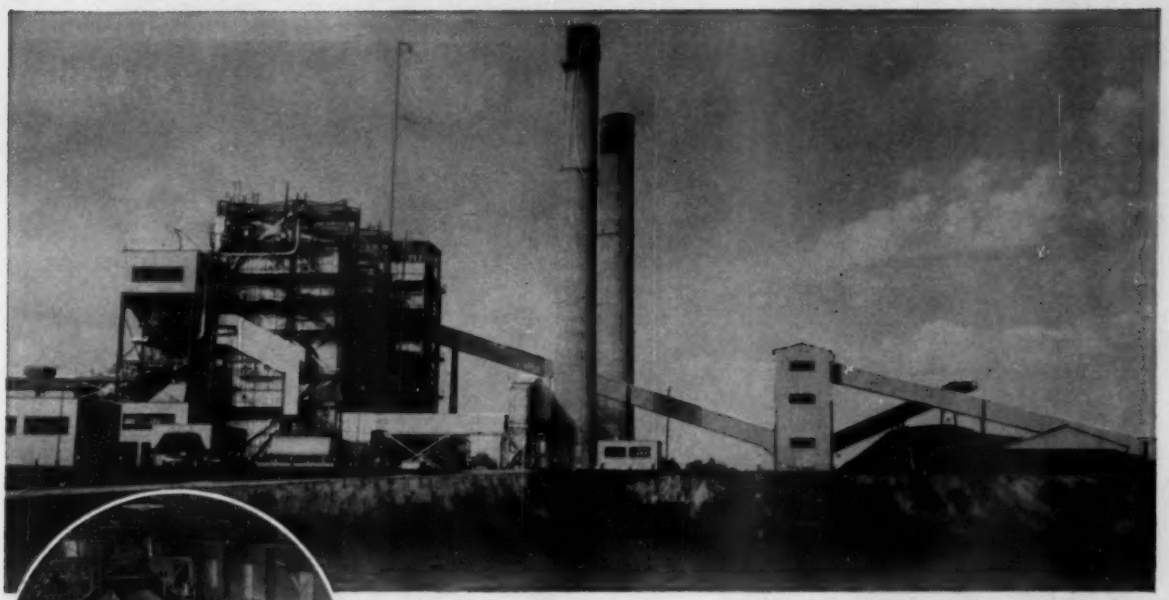
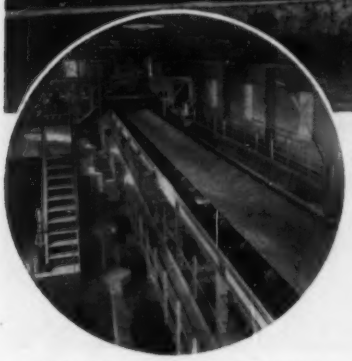
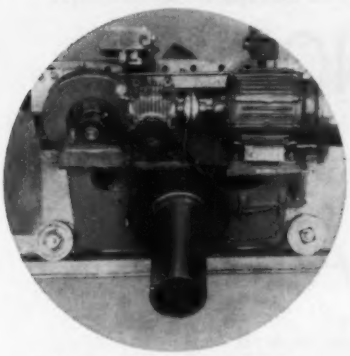


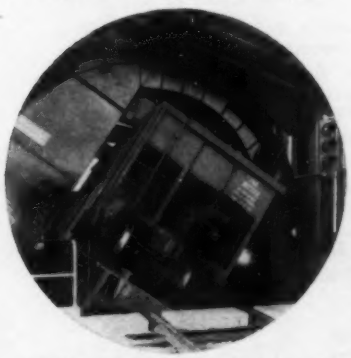
H & P Built the Complete Coal Handling System for Carolina Power & Light Company's Lumberton Station. Engineers & Constructors: Ebasco Services Incorporated.



H & P Coal Conveyor and Tripper



Reciprocating Thorsten Coal Sampler



H & P Rotary Railroad Car Dumper with Integral Electronic Scale (Pat. Pend.)

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TRACERS

Power Engineering's Monthly Probe of Power Facts

Tampa Electric gets industry's first isolated phase bus run capable of operating at the highest thermal rating ever specified for a generator conductor. Built by G-E, the newly-designed bus duct will operate at a maximum hot spot temperature of 105 C. Design was selected for electrical efficiency and ability to achieve cost savings.

Eight-day experiment, in which electricity was directly produced from a radioisotope using a thermionic converter under gamma radiation conditions, has been conducted by G-E. Gold was used as the radioactive source material. This demonstration was designed primarily for space vehicle auxiliary electric power applications. But G-E engineers believe their system has the potential to produce an extremely high ratio of power to weight. A power pack generating more than 100 watts of electricity and lasting more than a year could weigh less than 25 lb, they point out.

Advance in the art of power plant engineering is the 6 x 6 Flexibility Matrix method for stress analysis of intricate piping configurations, using a high speed electronic computer. Rochester Gas and Electric Corp has proved the practical time-saving advantages of the new method. See B. R. Wheelock's article, page 94 this issue.

Philadelphia Electric's supercritical unit at their Eddystone station, scheduled for operation this fall, will ultimately operate at steam conditions of 5000 psi and 1200 F. According to Westinghouse, manufacturer of the turbine, the unit will go into initial operation at the 1150 F level and steam temperature will be raised to the higher figure later in the operations schedule. If successful, this will represent the first major metallurgical penetration of the 1050 F ceiling for large turbine generators.

Revival of interest in the electric automobile continues to grow. Stinson Aircraft Tools & Engineering Corp of San Diego is reported ready to offer a three-passenger electric sports car powered by conventional lead-acid batteries supplied by Exide. First customer is Atlantic City Electric Co; the price, $2200. Car has a 77-mile driving range, speed of about 60 mph.

Polypropylene is its name, and it's the lightest plastic, yet possesses exceptional toughness and structural strength. It's the first polyolefin plastic with high enough heat resistance to permit repeated steam sterilization without distortion of shape. AviSun Corp has been formed by American Viscose and Sun Oil to supply the new material commercially.

Why nuclear power? The most important reason for developing nuclear power is that this new, highly concentrated source of energy will enable us to conserve our valuable fossil fuel reserves. As indicated in the article by Harry Kuljian in the ATOMICS section in this issue, our fossil fuel reserves are rapidly being depleted, and because of this it is imperative that nuclear power development be accelerated. Mr. Kuljian's plan for accelerating nuclear power development is well worth attention.

Industrial Power Plant Accounting

By JOHN S. COLE, P.E.

Basis of economical power plant operation is an effective set of operating cost data. Here is the first of a series of articles by an expert in the operating field explaining in detail how to . . . . .

Set Up Cost Data for Operating Economy

BASIS FOR ANY successful utility operation, as applied to a manufacturing or industrial plant, requires a very accurate breakdown of cost of each of the utilities necessary for operation of the plant.

It is extremely difficult to set any common basis, in order to compare operating costs between plants. This is due almost entirely to the wide variation in size of plants, methods of operation and the plant utility requirements.

In addition to wide variation in plant operating characteristics and utility requirements, there are many differences in accounting systems and methods used to charge off utilities against the various operating sections. To further compound confusion there often exists a variation in the costing practices between plants operated by the same company.

As a result there is really no way for the utility engineer to compare his practices and costs with those of other plants. He can only compare costs with those of preceding operating periods and endeavor to equal or better his own performance.

Charging off of utility costs for small plants is a comparatively simple matter. If the plant has only one end product all utilities costs can be lumped and charged off as overhead, or part of the general operating cost of the plant. As the plant grows in size and more product lines are added, each line should bear its proper share of utilities costs as part of the overhead cost of operating that line.

Thus, as the plant increases in size and more utilities are required to operate the product lines, the matter of charging those utilities to the operating sections becomes more complicated. The utilities group then takes on the character of a separate, self-liquidating operation within the plant. It is at this plant that accurately maintained figures on operating costs pay off for the plant.

Top management of many industrial plants look on the utilities section as a necessary evil to be buried in plant overhead charges, and never exhumed except in times of severe recession. This is indeed a false concept, for utilities consumed are the raw materials of manufacturing just as much as are metals, plastics and woods that go into the finished product. Reduction in the cost of utilities will reflect a savings in manufacturing costs on all product lines. This could have tremendous effect on status of the plant.

Six Basic Factors Involved

Regardless of size of plant and methods used to charge off cost of utilities, there are six basic factors which constitute the cost of operating the utilities section of a plant: 1. operating labor; 2. maintenance labor; 3. overhead; 4. supplies and materials; 5. fixed charges and 6. fuels and purchased utilities.

Charge for operating labor covers all labor devoted to actual operations necessary for generation and distribution of the utilities. This would include firemen, pump and machinery operators, water treaters and the like.

Maintenance labor covers all labor charges against maintenance of basic utility equipment, as well as distribution systems necessary to carry utilities to the various operating sections.

Overhead charge covers all expense necessary for operation of the utilities section. This charge is made up of some, or all, of the following factors, depending on size of the plant: 1. supervision; 2. office and clerical help; 3. stock handling and stores personnel; 4. cleaning and general labor; 5. overtime pay; 6. shift premium pay; 7. vacation pay, holiday pay, sick pay, life and health insurances and the like; 8. stationary and office supplies; 9. telephone and telegraph; 10. general supplies and small tools; 11. travel and trucking expense; 12. charges assessed for building maintenance, light, heat, watchman services and the like; and 13. charges assessed for services of other sections, such as administration, purchasing, accounting, personnel and the like.

Fig. 1. Breakdown of operating dollar

In general, overhead charges are lumped and charged out against operations as a percentage of the total cost of operating and maintenance labor. Overhead costs will range up to 100 per cent of total labor costs. If overhead exceeds 100 per cent of labor costs, the head of the section should scrutinize the cost breakdown carefully and take steps to reduce charges to a more reasonable level.

Charge for supplies and materials necessary to operate and maintain continuity of the utility: 1. lubricating materials; 2. boiler and water treating chemicals; 3. steel plate and shapes; 4. pipe, valves and fittings; 5. fire brick, clay, cement and insulating materials; 6. gasket and packing materials; 7. bolts, nuts, screws, rivets and the like; 8. machinery replacement parts; and, 9. wire, conduit, switches and other small electrical components.

Fixed charges are costs over which the department head has little or no control. This charge is made up from the following: 1. depreciation of equipment; 2. building and equipment insurance; and 3. taxes on building and equipment.

Final allocation of charges is for fuel and purchased utilities to operate the plant. Division of funds between these two will vary with size of plant and type of operation. If all utilities are purchased, with the exception of steam for heating and process, the purchased utilities portion will be large, and the fuel part

will be small. As less utilities are purchased, and more generated within the plant, division of this part of overall utilities funds will change.

How Utility Dollars Are Spent

Let us now assume that we have a plant utilities dollar to spend. In a modern and well operated plant, the dollar could very readily be divided up as shown in Fig. 1. Operating labor could require 10 cents; maintenance labor could take 6 cents; overhead might require 15 cents (note that overhead is equivalent to about 94 per cent of combined operating and maintenance labor costs); materials and supplies take 6 cents; fixed charges claim 15 cents; fuels and purchased utilities take 48 cents. The total is $1.00.

Since the utilities engineer is trying to hold the line on his operating expenses, he should chart his expenses for each year. This will give him a ready reference so that he easily can determine which part of his plant operation is out of line and thus be in position to take corrective action. He can arrive at an averaged cost, and can use such a chart for preparing his operating budget for succeeding years. Figure 2 is a bar chart showing how the cost of operating a plant utilities section will vary over a number of years, and how these costs will average out.

It should be noted that there is a maximum 1½ per cent variation in total cost of overhead, operating and maintenance labor over an eight-year period. Also note that during the same period, variation in fixed charges shows a maximum of 1 per cent. Largest variations are in supplies and materials; fuels and utilities. This can be accounted for by annual weather variation. A cold winter would require more heat; a hot summer would require more utilities for air conditioning. Harder the equipment is used to cover the above conditions, the greater will be the amount spent for operating supplies and maintenance materials.

After analyzing utility costs and arriving at an effective cost control system, the utility engineer must make a similar analysis of each utility he controls so that he can properly apportion charges to those industrial sections using the services.

First basic raw material used in the utility section is fuel. Pricing is greatly simplified. If the plant uses more than one fuel, the job becomes more complicated; the engineer must keep a running account of costs in order to shift operations and burn the fuel giving the least cost per unit of steam generated.

Fuel used may generate steam for heating, process work and generation of electricity. It may also be used in prime movers to provide refrigeration or air conditioning. Regardless of usage, the same basic factors will bear on fuel costs.

There are several factors which govern cost of fuel. First, the fuel must be purchased, and it must then be delivered. Next, there will be labor involved to operate fuel handling equipment, and to maintain it. Since labor is involved, we must apply an overhead charge to cover supervision and the like. Maintenance and operation of coal handling equipment will also necessitate expenditure for operating and maintenance supplies.

Fixed Charges Count Too

Since coal handling and storage equipment requires an expenditure of capital money to purchase and install it, fixed charges must be applied to cover that money. Finally, power to operate the coal handling equipment must be charged off against it.

Due to the wide variety in types of coal handling equipment and variation in quantity of coal burned in different plants, no set formula can be derived to compute costs of the various factors listed here. Each engineer must accumulate figures for his own plant. Since coal is purchased by the ton, most convenient basis for all cost computations is also the ton. Once total costs have been established for a period, division of those costs by the number of tons handled will give unit costs for this fuel. Table I shows a typical breakdown of these fuel costs, as applied to determine cost of coal at the bunker.

Having established cost of fuel at the bunkers, we can now determine cost of the fuel as fired in the furnace. The same factors as applied above will apply to the cost of burning the fuel. Table II shows how to compute cost of fuel as fired.

In order effectively to illustrate the pricing of fuel, it is now necessary to make certain assumptions. First, assume that the coal is of a good grade, having a heat content, on analysis, of 13,600 Btu per pound. It is burned in a boiler that operates at 250 psi pressure and 550 F total temperature. The boiler operates consistently with an efficiency of 80 per cent. Feed water enters the boiler at 300 F. With this as a starting ing point, we find from the steam tables that steam at 250 psi and 550 F has an enthalpy of 1290 Btu per pound. Feed water at 300 F has an enthalpy of 269.6 Btu per pound.

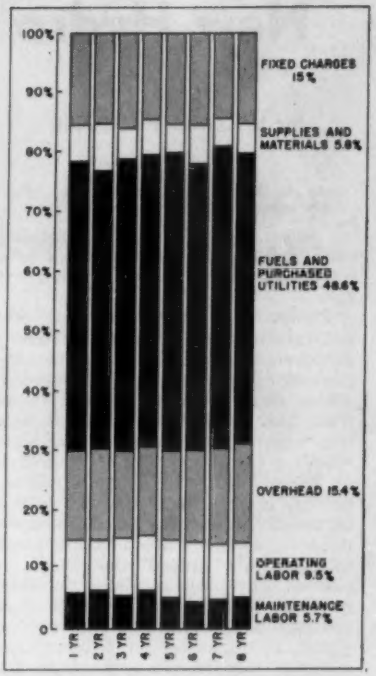

Fig. 2. Chart showing how cost of operating plant will vary over the years

Enthalpy of steam 1290.0 Btu/lb
Enthalpy of water 269.6 Btu/lb
Heat to be added in boiler 1020.4 Btu/lb
Heat to be supplied to boiler $\frac{1020.4}{80\%} = 1275.5$ Btu/lb

Heat to make 1000 lbs steam = $1000 \times 1275.5 = 1{,}275{,}500$ Btu
Heat of fuel = 13,600 Btu/lb
Fuel to make 1000 lbs steam = $\frac{1{,}275{,}500}{13{,}600} = 93.8$ lbs

Coal costs, per lb = $\frac{\$12.10}{2000} = \$0.00605$

Fuel costs per 1000 lbs steam = $93.8 \times .00605 = 56.7¢$ per 1000 lbs

Editor's note: Mr. Cole will continue this timely discussion next month.

Table 1. This breakdown shows cost of fuel at storage tank

Coal cost, per net ton	$ 5.00
Delivery costs (freight, etc.) net ton	4.42
Operating labor	.32
Maintenance labor	.03
Overhead costs	.35
Materials and supplies	.04
Fixed charges	.09
Internal power usage	.11
Total cost of fuel at storage, net ton	$10.36

Table 2. This breakdown shows cost of fuel as it is fired

Coal cost at bunker, net ton	$10.36
Operating labor (firing, ash handling, etc)	.40
Maintenance labor (fans, stokers, pulverizers, etc)	.08
Overhead	.48
Materials and supplies	.06
Fixed charges	.21
Internal power usage	.54
Total cost per ton, as fired	$12.10

New Hydro Gland Packing Really Works

By WILLIAM BUCKSHEE

Problem of gland sealing on hydroelectric turbines has long been an industry headache. If packing is tight the shaft is cut. If it is not, leakage is excessive. This new seal presents an ingenious solution

STUFFING BOXES, glands, and especially water sealing packing have posed a problem for engineers since the dawn of the mechanical age.

Design of a suitable stuffing box is a quite simple mechanical problem; however, the choice of a satisfactory packing is quite another. Experience shows that packing, whether made from flax, asbestos or metallics, and impregnated with tallow or graphite; whether they were braided, twisted or formed, all had inherent weaknesses. Some broke up and disintegrated. Others folded back upon other layers in the stuffing box. Some swelled. All caused the shaft or sleeves to score, resulting in deep grooves. This, in turn, made it more difficult to maintain a seal at the gland. It might be pointed out that some of the trouble arose from the erroneous thinking that the gland on a turbine should be free from any leakage. For this reason many operators tightened the gland unduly, thereby causing the packing to bite into the shaft. Actually, slight water leakage at the gland of a turbine is of no consequence. It is, in fact, desirable; a young Niagara is not.

With the advent of plastics and synthetic materials, the packing people naturally turned to these newcomers for appraisal and application.

For the seal on turbines, a V-shaped synthetic rubber was tried out. Although satisfactory during summer, it did not stand up to winter's low water temperature and became brittle. (We are here dealing with turbines with water lubricated bearings.)

Later, the silicones appeared. One packing company came forward with a silicone split "Klozure" which has proven to be impervious to the water temperature range met with in Northern Canada. This klozure is V-shaped and measures only 1 in. by ¾ in.

The sketches show that a slight change must be made to the gland to accommodate the klozure, and although the adapting rings could be made from cast iron or plate, it was felt that aluminum or bronze would make for a better job. On one job aluminum was used, on another, bronze. Both were entirely satisfactory. Aluminum alloys, perhaps, have the advantage on very large units because the problem of weight must be considered. It is not easy to rig on the under side of a large generator rotor.

A brief description of an actual changeover is perhaps in order. First, careful measurements of the shaft or sleeve are made, since to function properly, a true surface is requisite. On units with split sleeves, these can be removed and rebuilt. In the case of a scored or grooved shaft, however, some measure must be taken to correct the condition. Since the removal of a shaft for machining is a major operation, the easiest way out of the difficulty is simply to make an adapter that raises the location of the gland on the shaft.

The klozure is ordered giving the actual shaft or sleeve diameter. Exact measurements are required since the packing ring can not be altered in the field.

Turbine working drawings are all that is necessary for designing the aluminum or bronze rings. As shown in the sketches, the rings are fastened where the gland formerly fitted. Receptacle where the klozure rests is made size for size. Although no difficulty was experienced with leakage, it is suggested that should undue leakage be encountered, this can be overcome by inserting brass shims around and between the klozure and the upper bronze ring.

It is somewhat surprising that one klozure takes the place of six to eight layers of conventional packing, and makes use of a material having practically no abrasive qualities. One small point which might be pointed out is that under normal operating conditions there is a pressure on the turbine. Doubtless, this pressure against the under side of the packing tends to press it against the shaft, making for an ideal seal.

One hydro station in Canada has now had these "Klozures" in operation for nearly two years, completely trouble free. It would appear that the engineer who thought this one up deserves some sort of medal from his hydro friends. THE END

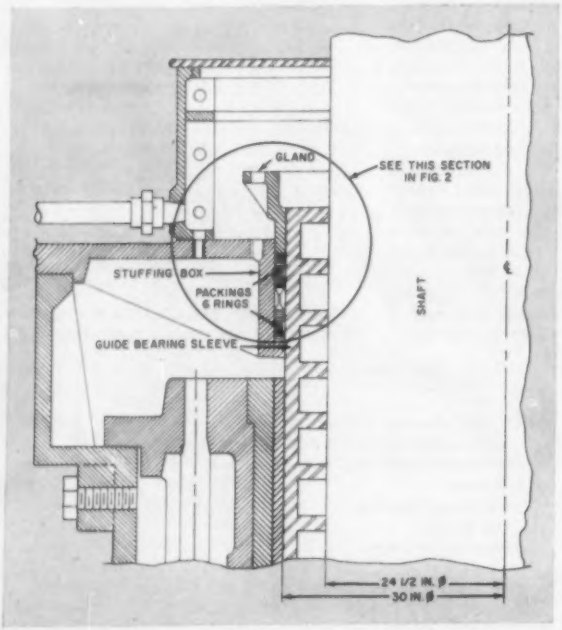

Fig. 1. Sketch at left shows a conventional stuffing box and packing. In order to accommodate the new seal, the packing gland shown here is replaced with bronze or aluminum rings

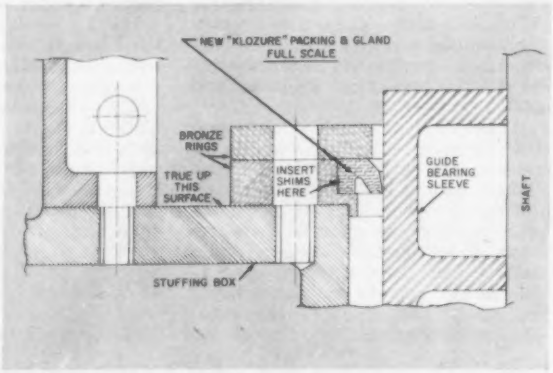

Fig. 2. Above. This drawing shows position of the new silicone packing ring and the metallic retaining rings that replace conventional glands. Shims are used for adjustment

Electrical transmission voltages are constantly increasing, as power demands go up. In addition to the need for greater insulation, designers must cope with problems of corona and radio interference. This article deals with the solution to some of the problems involved

Large Aluminum Conductors For EHV Lines

By W. J. NICHOLLS*

TODAY, THE VOLTAGE for transmission is constantly rising, due to the growing demand for moving large blocks of power over great distances, coupled with the parallel development of transforming and switching equipment to operate at higher voltages.

For overhead transmission lines, this has involved increased insulation, larger spacing between phases and larger conductors, to overcome corona losses and radio interference.

Up to 250 kv, a single conductor per phase meets the requirements, although the diameter of the conductor has to be sufficiently large to avoid corona.

Above 330 kv, the size of the single conductor becomes over 1½ inches in diameter, costing over $3360 per mile, and giving a surplus of conducting material. It is then economical to use a *bundle* of 2, 3 or 4 smaller conductors for each phase. For 380 kv lines in Britain, France and Sweden, twin conductors are used; and, for 400 kv lines in Russia, bundles of 3 conductors. In Germany, bundles of 4 conductors are used for 380 kv. (See Fig. 1.)

The transition between single, and bundled, conductors occurs between 250 kv and 330 kv. On the British 275 kv lines, twin conductors are used, but it has been shown that a single conductor of 1.239 inch diameter has similar corona and radio interference characteristics to twin conductors of 0.770 inch.

Single vs Bundled Conductors

This means that, in this range of voltages, the choice of single, or bundled, conductors depends upon factors other than corona. The advantages of the SINGLE conductor are:

(1) Lower over-all cost of the line
(2) Higher reactance permitting lower switchgear rupturing capacity
(3) Lower capacitance and lower charging current
(4) Lower resistance reducing I^2R losses
(5) Lower ice and wind loads, enabling lighter supports to be used
(6) Less sag for a given span, or longer spans
(7) Stronger individual conductors — for mechanical overloads
(8) No complications with spacers and twisting of bundles.

Against this the advantages of the TWIN conductors are:

(1) Increased power transmission capacity, and stability, on long lines
(2) Lower cost of conductors
(3) Lower broken-conductor loads on structures, if one conductor only is broken.

All these factors have to be considered for any proposed transmission line, where the ideal voltage on purely electrical considerations lies between 250 kv and 330 kv.

If the decision is in favor of using a single conductor, there is then the question whether it should be of conventional stranding, of expanded construction or of special stranding.

Experience with expanded conductors has not been entirely satisfactory. One would naturally turn to ACSR of the recognized strandings, such as 54 aluminum over 7 steel; or 54/19 (89 percent aluminum by volume); or to the special strandings applicable to large conductors, such as 45/7 (93.5 percent aluminum), or 42/7 (95.1 percent aluminum).

Canadian Experience

When Quebec Hydro built the first 300 kv line from Bersimis to Montreal, 54/19 conductor was chosen, with a diameter of 1.382 inches. (Known as "Pheasant" type.) This operated satisfactorily. For the second line, a 42/7 conductor, with a diameter of 1.380 inches, was chosen. This conductor, having a larger proportion of aluminum, reduces the I^2R losses, has similar sag characteristics and practically the same corona values. (Called "Bersimis" type.)

A conductor of this size, operating at 300 kv, is very near the point at which corona losses mount rapidly — either with small increases in voltage, or *with any roughness of the conductor surface.* (See Fig. 2.)

The importance of the surface condition of the conductor may be gathered from the difference in the calculated critical corona voltage for 1.380 inch diameter conductor. This voltage varies from 210 kv for a *rough surface*, to 312 kv for a *perfectly smooth* and weathered surface. This is for the disruptive critical voltage, which is important from the radio interference aspect; however, the calculated visual critical voltage, more important from the power loss aspect, is well above these figures at 484 kv power line operating voltage.

Corona tests of the Bersimis first line conductor (and fittings) proved that it withstood 400 kv without visible corona, and 345 kv within the limit of 100 microvolts radio interference.

Smooth Surface Precautions

In order to ensure a smooth surface, Quebec Hydro issued the following specification:

"In addition to normal inspection procedures, called for under C.E.S.A. Spec. C49-1940, the following inspection and handling procedures must be carried out.

1. Rod and Rod Handling
   The handling, inspection and possible conditioning of rod is the responsibility of the manufacturer.
2. Inspection Control of Wire for Outside Layer
   (a) Visual inspection of visible surface of wire on all spools.
   (b) Special precautions to be undertaken by the manufacturer, to eliminate the possibility of damage in handling the outer 20 spools from wire drawing, to inspection, to strander. These spools will have a wrapping of suitable material around the drum as well as the outer surface of the wire.
3. Inspection of Finished Cable
   (a) Outer layer of conductor on each reel to be carefully inspected, on the reel, for surface imperfection, by Hydro-Quebec inspection representatives.
   (b) Surface imperfections which are not acceptable on finished cable may be conditioned by using fine emery paper.
4. Inspection of Reels
   All reels will be carefully inspected for nails or projecting rough spots that might cause possible damage to conductor. Reels to be approved by manufacturers and Hydro-Quebec Inspectors." (See Fig. 3 for reels of cable ready for shipment.)

Having produced a perfectly smooth conductor, it is most important to see that the surface is not damaged during running-out and erection. Formerly, it was the practice to run out conductors by dragging them over soft ground and pro-

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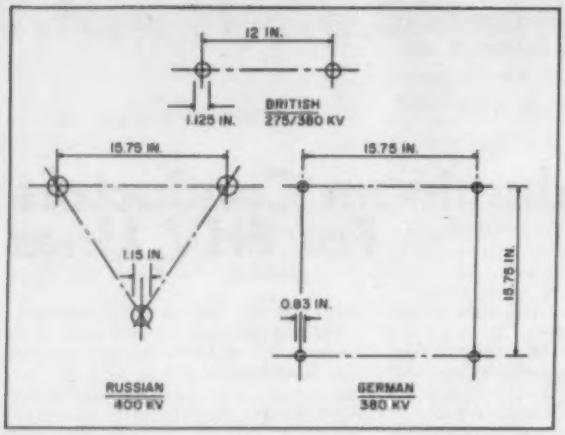


Fig. 1. Drawing illustrates configuration of bundled conductors for voltages over 300 kv, in Britain, Russia and Germany

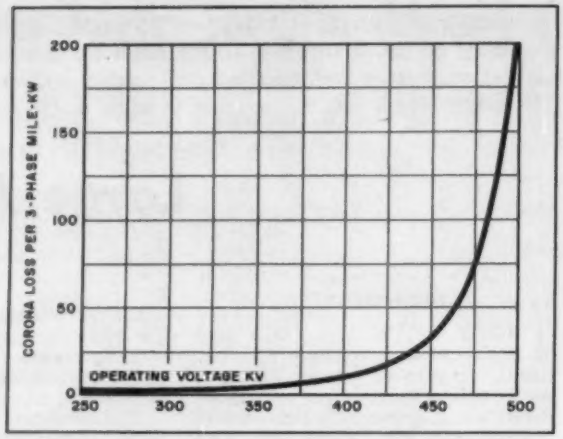


Fig. 2. Curve showing rise in corona loss, as operating voltage increases. Note rapid rise as voltage goes above 350 kv

tecting them from damage by wooden trestles when rocky ground, stone walls or other abrasive obstructions were encountered.

Recently, tension-stringing has been widely adopted, and by this means the conductor is kept under a tension sufficient to keep it clear of the ground during the entire running-out process.

To simplify erection still further, *the conductor can be supplied in lengths of up to 7,000 ft*, on steel reels, in place of lengths on wooden reels which are little over 4,000 ft.

The steel reels are mounted on special braking machines, which pay out the conductor under a tension developed by threading the conductor around Neoprene-lined pulleys to which the brake is applied. At the other end of the section, a winch winds in a steel wire rope connected to the end of the conductor.

With this method, the conductor is held clear of the ground, and its surface is not damaged by dragging it over rocks or other rough objects. Also, the conductor does not pick up loose particles of earth or vegetation which could cause corona discharge.

Another instance of the use of a single conductor at high voltage is the 330 kv Snowy Mountains Hydro lines in Australia. The conductors used for the majority of the transmission lines are twin 61/.117 inch ACSR, but for a section of the lines (at an elevation of 5,000 ft where severe icing is known to occur), a single conductor has been adopted. This is 91/.161 inch special aluminum alloy with a diameter of 1.771 inch, which is fully adequate for 330 kv operation at high altitude. This one-conductor construction minimizes winter maintenance. In this instance the choice of a single large conductor was governed solely by mechanical considerations.

The new transmission system in Rhodesia — distributing power from the Kariba dam — is also being built to operate at 330 kv. All the 964 route-miles of transmission line employ twin 61/.118 inch ACSR conductors. It is only in the substations where single A-A flexible conductors are used as bus material. These conductors consist of 127/.169 inch aluminum strands, with a total diameter of 2.197 inches. This large size was selected to insure satisfactory operation at the high ambient temperatures prevailing in parts of Rhodesia, and also to insure complete freedom from corona at the high altitudes of some of the substations.

With the advent of the present high-voltage ac transmission schemes, and with the prospect of voltages reaching 750 kv within the next few years, the conductor manufacturer is ready to assist; both in providing larger conductors, and also in insuring that these conductors have a perfect finish — to mitigate the ill effects of corona losses and radio interference.

There is also the immediate prospect of very-high-voltage dc transmission; a line of 400 kv is already under construction in Russia, with the possibility of even higher voltages in the near future. This application calls for the same degree of cooperation from the conductor manufacturer.

Editor's note: More articles on electric transmission line will appear in coming months. The Canadian lines, mentioned in this article, were inspected recently by one of our touring editors from POWER ENGINEERING.

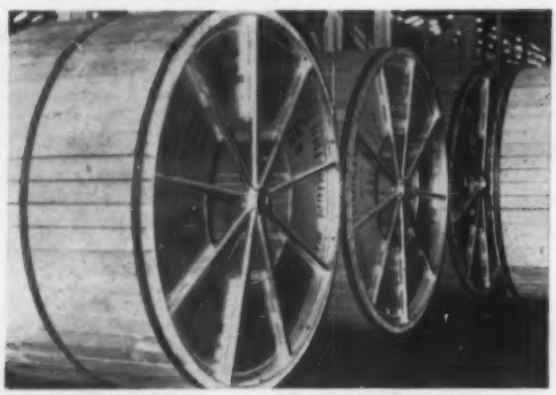


Fig. 3. Steel reels of conductor, ready for shipment to Bersimis. Lengths of 7000 feet can be supplied on these reels

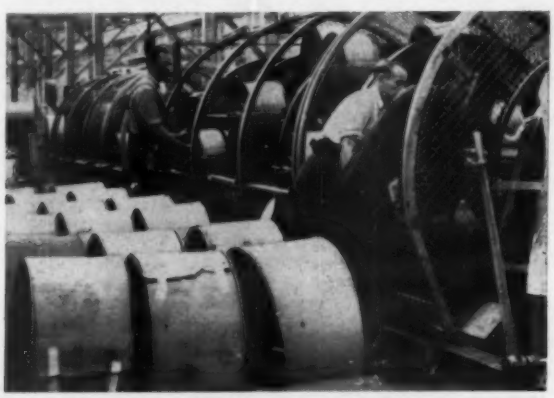


Fig. 4. Photo shows in-plant care that must be taken to protect strands of conductor. Note paper-wrapped spools of wire

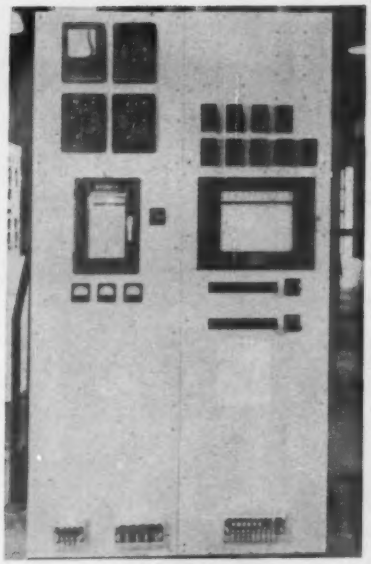


Fig. 1. Central station equipment rack for remote capacitor-switching system

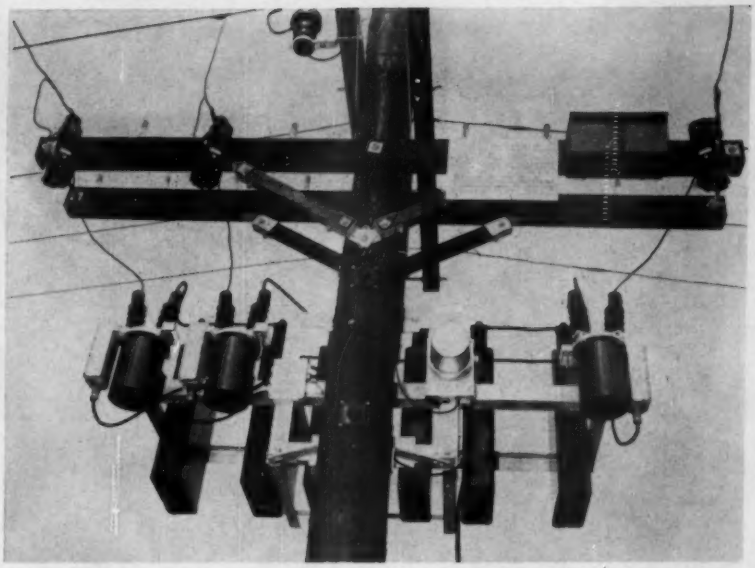


Fig. 2. Receiver-decoder unit of the remote switching system. Housed in a standard watthour-meter case, this equipment switches the capacitor bank shown nearby

Capacitor Switching By Remote Control

By CHARLES WASSERMAN*

Increased use of capacitors, for voltage correction, has created problems of automatic switching, as loads vary. Baltimore Gas and Electric does it successfully with carrier-current signals. Receivers, at capacitor locations, get impulses from transmitters at stations

IT IS NOW WELL RECOGNIZED that reactive requirements of electric systems have materially increased during the past ten years, and are expected to further increase with presently estimated system expansions. Studies indicate that in the next ten years approximately 500,000 kvar of capacitors will be needed on the Baltimore system, along with other installations representing fixed capacitance, such as high-voltage cables and high-voltage overhead lines. The added capacitors will have to be switched, during light-load periods, to avoid generator and regulation limitations.

To obtain the greatest practical benefit of the use of these capacitors, it is planned to install the majority of them as close to the ends of the 3-phase mains of the 4-kv distribution feeders as possible. And, by properly controlling the capacitor switching, to obtain the desired voltage regulation with a minimum of conventional regulating devices, such as feeder-regulators and load-tap-changing on transformers.

For the past several years, we have been designing our system on the basis of remotely-controlling groups of capacitors from the various 4-kv substations, to obtain best overall advantage. To date, we have omitted the purchase of load-tap-changing equipment on 13 transformers, ranging in size from 48 to 53 mva, for a savings of over $1,000,000.

We have also removed several existing feeder regulators on one substation, and plan to do so in other stations. We control the capacitors either by voltage, or reactive load, measured at the station, depending upon prevailing conditions. Where existing voltage-control is still adequate, we control by reactive vars for minimum losses; at other locations, we control by voltage.

Equipment Used For Control

The remote-control equipment consists of a conventional power line carrier transmitter, with spare unit, coupled to the station bus. The receivers are transistorized, and mounted in a socket-type meter housing, along with the necessary auxiliary equipment. All our capacitor installations are now factory-equipped with meter sockets, which permit the installation of time clock, remote receiver, or local-voltage control.

Figures 1 and 2 show typical transmitter and receiver installations. Various audio tones modulate the transmitter to operate the "on and off" functions of the individual receivers. A recording reactive meter is provided at the station to indicate the operation of the switched capacitors. This recorder also serves as a reactive monitor, where var-control is used.

Key switches are provided at the station for individual manual control, to test the operation of the switched capacitors, thus avoiding the need for pole-location inspection. The equipment is flexible and permits other functions to be used for initiation of the control for capacitors, if necessary.

Performance Data

We now have 195 receiver units in service, together with 11 station control points. The cost of the remote-control installations averages less than $2.50 per kva. It is expected that this figure will be reduced to $1.50 per kva when additional capacitors are added to the feeders on the stations with remote-control facilities. The number of capacitors initially installed were required for load relief. And, as the load grows more capacitors will be installed, thereby reducing the per-unit cost

* Baltimore Gas and Electric Co

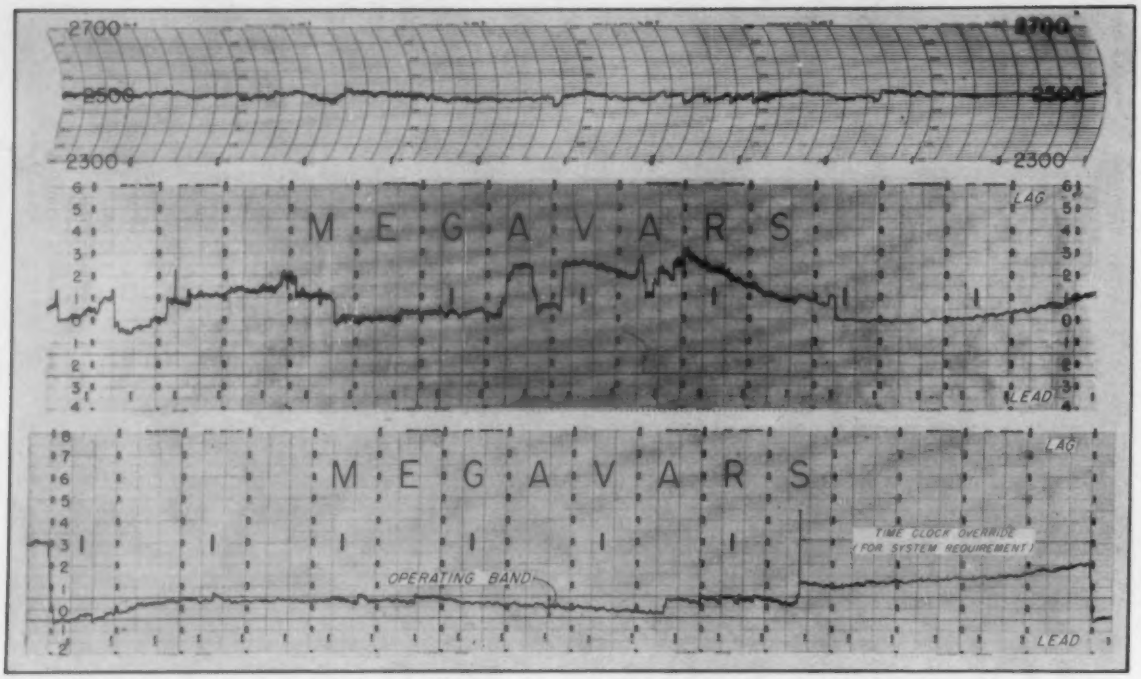


Fig. 3. These charts show effects of controlled-capacitor operation. Top chart is bus voltage for urban substation; middle chart shows kilovar load for same station. Bottom chart is total kilovar load for urban station using var control

of control equipment and facilities.

Approximately 100 receivers and 5 station control points have been in service for 18 months, with exceptionally few cases of equipment, or operational, failures. There have been no transmitter troubles, but there have been approximately 15 receiver equipment troubles, five of which were due to lightning and the others to a variety of causes. Several cases of undesired operation have been experienced due to "cross-talk" between audio tones. This has been corrected by reassignment of audio frequencies.

Figure 3 shows the bus voltage record at an urban 4kv substation, where the basic voltage control is accomplished by the remotely-switched feeder capacitors. A graphic var record is also shown, indicating operations of the control during the same period. In addition, the var chart for an urban station using var control is shown. The load-tap-changing equipment at this station is adequate for voltage control. The capacitor control materially reduces the duty on the tap-changing equipment, since the amount of regulation is reduced.

Also, Fig. 4 shows the bus voltage record of a rural 4-kv substation before, and after, the application of remote switched capacitors. The improved feeder voltage with capacitor-control permitted the bus voltage to be appreciably lowered, as can be seen. It is expected that the amount of present feeder-regulating equipment will be reduced on this station's feeders when the program of capacitor installation in the area is completed.

Simplified Approach Needed

The general application of remote-control capacitor switching usually encompasses several independent areas of responsibility, both in engineering and in operation. Therefore, the wholehearted cooperation of the several responsible individuals is required for successful application of the control scheme. To realize the considerable saving that can be made, and to obtain the improved voltage provided on the feeders, requires the same cooperation.

A major difficulty, tending to handicap the application of remote-control of capacitor switching, is the need for a simplified engineering approach. This is necessary to determine the optimum location of capacitors, and their combined effect on over-all regulation. Such a simplified approach has been developed, and an example is given below.

To determine the location and number of capacitor banks required to obtain desired regulation improvement, it is necessary first to make a simplified reactance diagram of the circuits in the area, showing reactances in terms of percentages on a common base (See Fig. 5). The voltage effect of each capacitor bank then can be readily determined as indicated. Banks are located as near the load as feasible, limited by the maximum voltage change permitted, per bank operation. The number of banks per feeder is a function of the total improvement desired on the feeder, based on an assumed nominal bus voltage.

The voltage of our 110kv system is independently controlled, and normally would provide three or four percent voltage rise during heavy load periods, as compared to light load. In the example shown on the diagram (Fig. 5), assume that the total peak load is 120 mw and 90 rmva, and that minimum load is 30 mw and 30 rmva. Assume that the 110 kv bus voltage is maintained at 100 per cent at light load, and that the voltage taps at the Master Station and the Distribution Station are set to provide 100 per cent voltage at light load with all capacitors out of service. At peak load the 104 per cent on 110 kv bus (and the improvement in regulation by capacitors) compensate for the voltage regulation of the loads indicated.

Calculations

To obtain the total capacitor regulation improvement, multiply the voltage change difference (per bank) between each major circuit element, by the number of capacitor banks that will be supplied through that portion of the circuit. This is then repeated for each branch of the circuit, and a summation of the individual changes will give the total improvement that can be supplied to the feeder point by the application of capacitors.

This capacitor regulation improvement is combined with the regulation assistance of the 110 kv bus, to ob-

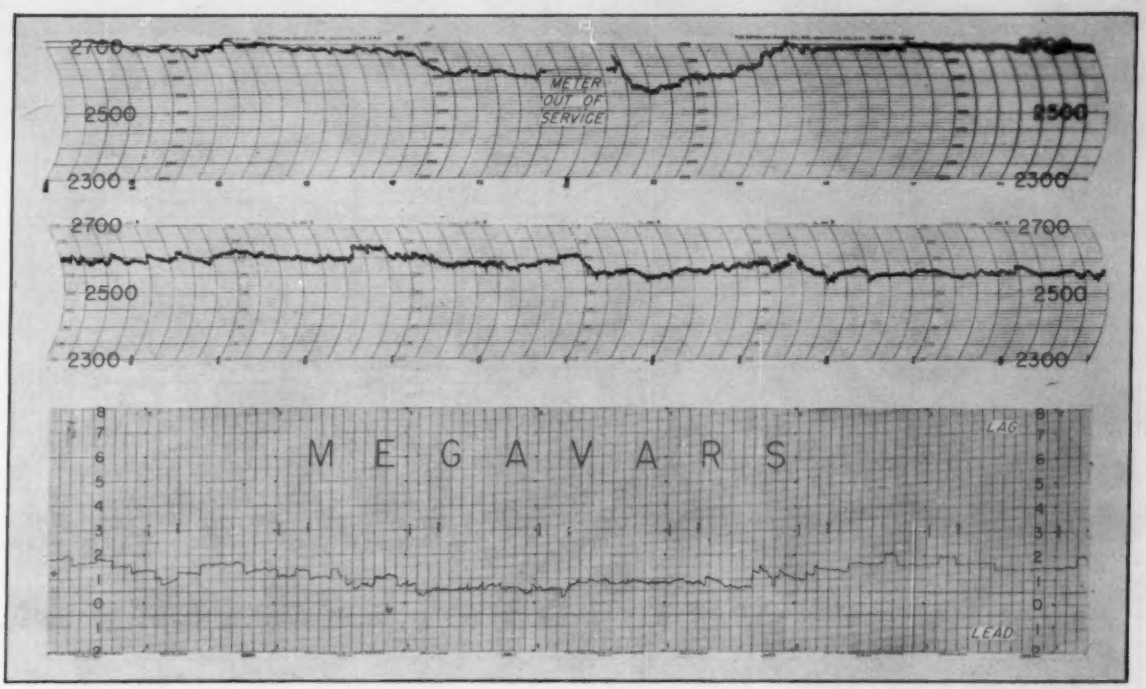


Fig. 4. Shown above is bus voltage record of a rural 4 kv substation, before (top), and after (middle), application of switched capacitors. Note bus voltage is lowered appreciably. Also shown is total kilovar load for substation area

tain the over-all regulation change. Outage of equipment has small effect on the overall regulation, since the increased voltage drop (by load) is compensated by the increased effect of capacitors.

The sequence of control is determined by requirements of the individual feeders. The banks on the same feeder are generally not closed-in consecutively. The sequence can be readily revised after installation, based on performance, as determined by voltage measurements at the feeder points.

Conclusions Drawn

To date, the remote control of capacitors has accomplished the anticipated improvements in the system economies and voltage profile. We plan to extend this control on our 4-kv system as the economics justify.

We also plan to apply this control to our 33-kv transmission system. Survey tests have indicated that the carrier frequency propagation produces sufficient signal on our 4-kv feeders supplied from the 33-kv transmission to operate the control equipment. We plan to install control on two 33-kv feeders in 1959.

Editor's Note: We feel that this excellent article by Mr. Wasserman demonstrates a good lesson in electric distribution economics. The rapid growth in consumer loads has presented continuing problems to all utility companies; and, these problems are expensive ones to solve.

As pointed out in the article, a carefully engineered system of remotely-switched capacitors will save thousands of dollars in capital investment. Also, improvement in voltage regulation, at the user end, should most certainly result in greatly improved public relations.

Apparently Baltimore Gas and Electric Co has had enough actual operating experience with this system to have convinced them of the overall value. And, such problems as have been encountered were not of a major nature, and have been solved.

The contents of this article are published through the courtesy of Edison Electric Institute, as the material was contained in a paper given before the seventy-sixth meeting of the Electrical System and Equipment Committee. This meeting was held in Charlotte, N. C., in October, 1958.

Carrier-current control equipment, as discussed in this article, was manufactured by Motorola Incorporated.

THE END

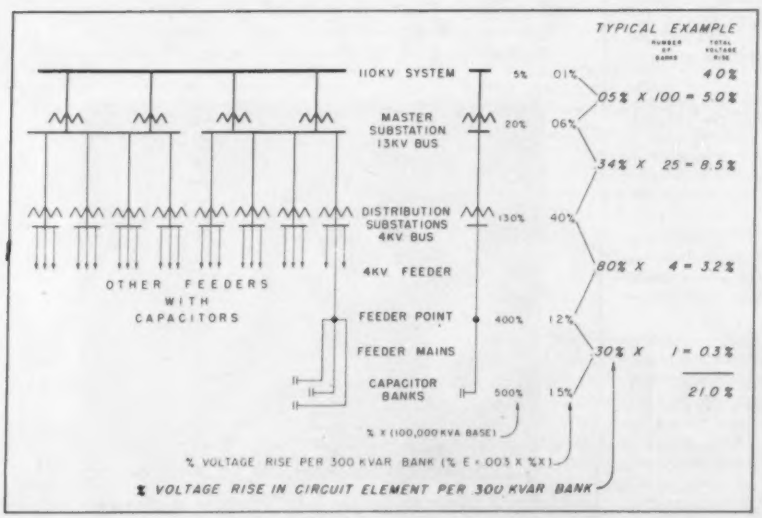
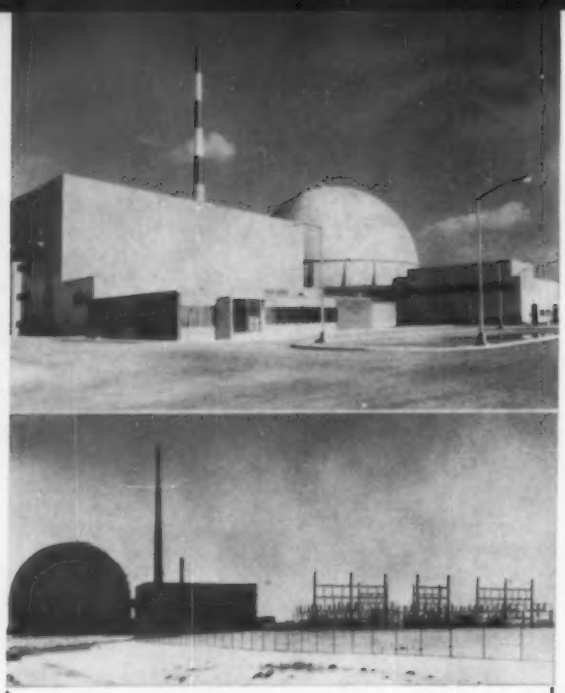


Fig. 5. Simplified reactance diagram of area circuits; reactances are in terms of percentages-on a common base. Voltage effect of each capacitor bank is shown



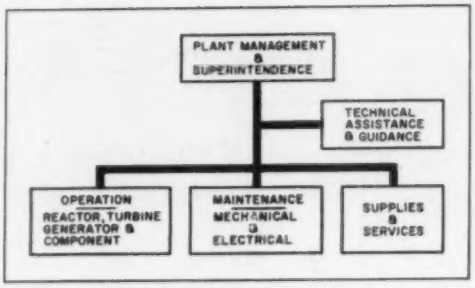

PLANT MANAGEMENT & SUPERINTENDENCE
TECHNICAL ASSISTANCE & GUIDANCE
OPERATION REACTOR, TURBINE GENERATOR & COMPONENT
MAINTENANCE MECHANICAL & ELECTRICAL
SUPPLIES & SERVICES

Fig. 1. The functions on which Dresden is organized

What It Takes To Man

THIS IS DRESDEN STATION TODAY

Entirely privately financed, Commonwealth Edison Company's Dresden Nuclear Power Station will produce 180 mw (electrical-net) from the largest nuclear reactor under construction in the United States, a boiling water dual cycle reactor of 626 mw (thermal) capacity. The plant is being built by General Electric Company for a contract price of $45,000,000.

Under construction permit CPPR-2, issued by the USAEC on May 4, 1956, the General Electric Company, with Bechtel Corporation as engineer-constructor, broke ground at the site near Joliet, Illinois, in late fall of 1956. Major construction began on June 12, 1957.

The Nuclear Power Group is participating in financing the research development expense of the plant. Members of the group are the American Electric Power Service Corp, Bechtel Corp, Commonwealth Edison Co, Central Illinois Light Co, Illinois Power Co, Kansas City Power & Light Co, Pacific Gas and Electric Co, and Union Electric Co. These companies are paying $15,000,000 of the contract price for Dresden as a research and development expense. Commonwealth Edison is capitalizing $30,000,000 of the total, plus site and overhead costs.

Selection and training of plant personnel began in the spring of 1957, three years before the anticipated date of commercial operation, planned originally for July 1, 1960. The program provides for training a force of 95 individuals, the requirements for some positions being as long as 16 months and a minimum job training on others approximating four months.

Construction at Dresden is approximately 70 per cent complete. Most of the essential plant components and systems are installed. Nearly one-half of the 488 fuel assemblies have been delivered to Dresden from the General Electric Atomic Products Department in San Jose, California. They have been unloaded at the site by Dresden Station employees and placed in the fuel storage vault to await the initial loading of the reactor in the fall.

Pre-operational testing of components and systems is getting under way. While many of these are conventional in nature, permitting the use of established test procedures, others are quite unconventional because of their nuclear aspects. Such components and systems require special test procedures.

Dresden personnel will assist in all of these tests, gaining operating experience on the actual station equipment. It is anticipated that pre-operational test activities will continue for some eight or nine months.

The plan is to have all Dresden employees at the site by the end of August. The training workload ahead will be mainly on-the-job training and courses in the five following areas: 1. basic nuclear education; 2. radiation protection; 3. Dresden Station equipment; 4. start-up instruction; 5. operator training.

As the employees complete their classroom and demonstration courses, they will be assigned their job duties where their training will be continued under their individual supervisors.

Fig. 3. Members of technical staff working on instrument mechanics' course. Left to right are: John H. Hughes, B. B. Stephenson, Warren I. Kiedaisch

Fig. 4. Shift engineers J. E. DeLeo, N. A. Kershaw, Howard L. Gann and William G. Barthelmes gain familiarity with the physical plant. This is the equipment entrance to the reactor enclosure

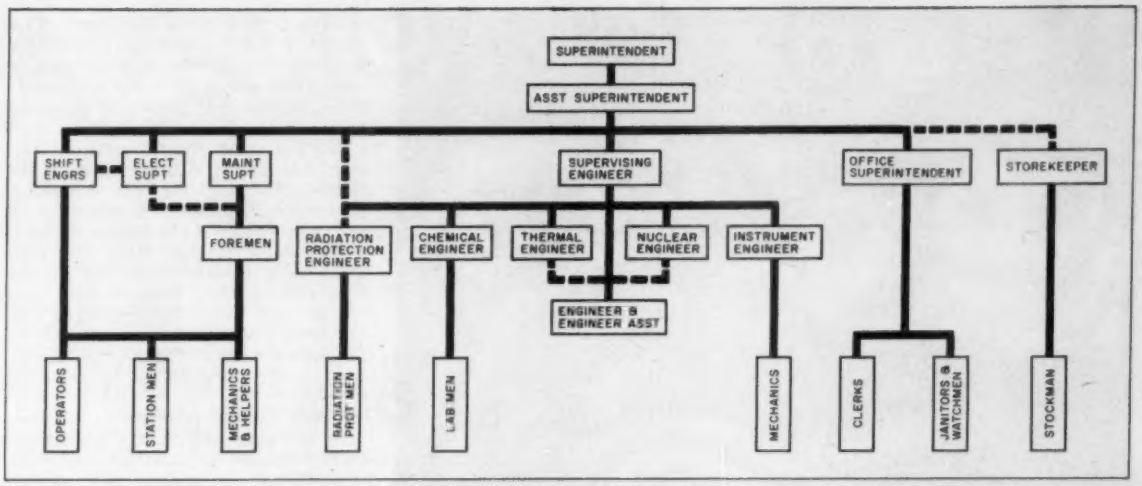


Fig. 2. Dresden Station personnel organization. At present 24 men have completed most of their training and are on site

a Major Nuclear Power Plant

By HARLAN K. HOYT* and HAROLD G. CARSON†

ORGANIZATION for operating the Dresden Nuclear Power Station is, to a large extent, like that of a conventional coal-fired plant. However, additional requirements are created by the use of nuclear fuel. Technical guidance and assistance are needed in such areas as nuclear engineering, radiation protection, nuclear instrumentation, radiation chemistry, maintenance in radioactive environment, operating a nuclear reactor, and handling and storing nuclear fuel and radioactive wastes. (See Fig. 1.)

Further analysis of the main functions indicates the elements of work to be done which, in turn, provide the basis of establishing jobs and positions to be manned. Character and quality of each job prescribes educational qualifications, experience and skills required by those who may fill the various jobs or positions. Established positions at Dresden have been arranged to attain the objectives set by the main functions, as shown in Fig. 2.

Selection of Personnel

The 95 workers for Dresden have been selected from within the company. Selections of individuals were made to anticipate completion of plant construction, training "lead-time", pre-operational tests, plant start-up, and other developments that require trained manpower.

General qualifications for station management and technical staff personnel, prepared in mid-1956 just three years before start-up, provided the basis for recruitment.

Station superintendent would be a graduate engineer with experience as a superintendent in one of the company's conventional power plants. He would have experience in operating and maintenance. He would have demonstrated his ability in handling people and be thoroughly familiar with the company practices, particularly with respect to labor relations.

Assistant station superintendent would be a graduate engineer with power plant and other company background. He would be capable of superintending general plant operations, have training in nuclear physics and experience in the operation of nuclear reactors.

Shift engineers would have some technical training at the college level and operating experience in one or more of the company's generating stations.

Electrical superintendent would be a graduate electrical engineer with conventional power plant experience. He would be familiar with the relationships between the reactor and its controls as well as more conventional electrical equipment of the plant.

Maintenance superintendent would be a thoroughly experienced master mechanic or maintenance foreman with some background, if possible, in work in radioactive environment.

Supervising engineer would have an engineering degree, generating station experience and nuclear know-how including a knowledge of means of radiation detection and protection.

Nuclear engineer would be a college graduate with experience in both conventional and nuclear-powered plants and a thorough background in nuclear physics and reactor engineering.

Radiation protection engineer would be a graduate engineer with a thorough knowledge of radioactivity and radiation protection and work experience in radioactive environment and personnel protection.

Radiation protection man would be experienced in generating station work and have an interest in the welfare of people. He would know how to service radiation protection instruments and be capable of making radiation surveys and pertinent records.

Chemical engineer would be a graduate and qualified chemist, with training and knowledge of radiochemistry. He would be thoroughly experienced in chemical problems in conventional power plants.

Thermal engineer would be a graduate engineer with generating station experience, a good knowledge of methods, practices and results analyses. He would have some knowledge of nuclear physics and reactor engineering.

Instrument engineer would be a graduate electrical engineer with considerable instrument maintenance experience and a good knowledge of reactor instrumentation and control.

Educational background and general qualifications for other positions in Dresden Station are sufficiently like those in the company's conventional plants that existing job descriptions would be adequate for selecting the remaining personnel according to schedules.

Training

Program that would meet the training needs of individuals selected to work in the Dresden Station obviously had to provide nuclear educa-

*Superintendent of Dresden Nuclear Power Station; †Staff Engineer, Nuclear Power Group

Fig. 5. J. H. Hughes (r), radiation protection engineer, giving instruction to group which includes maintenance foremen, shift engineer, control operator, engineer

tion as well as new skills and experience pertinent to nuclear applications. Some assignments would require a high degree of nuclear theory and others a low degree. Certain assignments would require the development of entirely new skills or an extension of old ones. Many would require a combination of theory and skills peculiar to nuclear operations.

Consolidation and analysis of all requirements permitted development of a carefully scheduled training program that will apply to Dresden Station personnel for many months to come.

Plant personnel were arranged into seven groups for training: 1. all personnel, 2. station and assistant superintendent and technical engineers, 3. shift engineers, 4. operators, 5. equipment attendants, 6. maintenance superintendent and foremen, and 7. mechanics. Individuals in each of these groups are scheduled to participate in whatever aspect of training their particular position requires.

Types of Training

Main categories of training are designated as follows: 1. indoctrination, 2. specialized training, 3. field training and 4. Dresden Station in-plant training.

Indoctrination is obtained by attendance at 80 hours of classroom lectures and discussions under the title, Basic Nuclear Education and Radiation Protection. Instructors are personnel of the technical staff. The course, for all station personnel except clerks, guards, and janitors, includes the following topics: history and background of Dresden Station, mathematics review, introduction to atomic power, the atom and its nucleus, mass and energy in nuclear reactions, instrumentation, elementary reactor physics, nuclear power plants, terms used in radiation protection, fundamentals of radioactivity, radiation instruments, biological effects and limits of radioactivity, protection from irradiation, protection in Dresden Station.

Specialized training is obtained at various facilities, mostly outside the Commonwealth Edison Co, where thoroughly qualified and experienced instructors and suitable training aids and demonstration equipment are available.

At the Atomic Power Equipment Department, General Electric Company, an 180-hour program titled Dresden Station Technology was given to 12 members of the Dresden operating and technical staff. Instructors, assigned directly from the General Electric design and engineering departments, taught the station superintendent, assistant superintendent, electrical superintendent, the six engineers on the technical staff and three shift engineers. The course was broad in scope with examples and problems taken directly from Dresden Station applications.

The Robert A. Taft Sanitary Engineering Center at Cincinnati provides three very fitting courses for specialized training in radiation detection and protection. Dresden's supervising engineer, radiation protection engineer, chemical engineer, and two shift engineers were assigned to the Sanitary Engineering Center for two weeks, six hours a day, taking the course titled Basic Radiological Health.

The Taft Center's courses in detection and control of radioactive pollutants in water and air are particularly applicable to work in nuclear environment. The course on pollutants in water was taken by the radiation protection engineer. The course on pollutants in air, five seven-hour days of lecture and laboratory work, was taken by both the radiation protection engineer and chemical engineer.

At Tracerlab, Inc, Western Division, Richmond, California, more intensive training for the radiation protection and chemical engineers is provided by the Radiochemical Operations Department. Here the program is a lecture-discussion-laboratory arrangement that requires two weeks' full time. The subjects and laboratory work, especially fitted to the actual requirements of the trainees, covered the following areas of activity:

Basic nuclear concepts — radioactive growths and decay equations; radiochemical separation methods, procedures, techniques and sample preparation; radiochemistry laboratory work; liquid and gaseous waste disposal problems; health physics; counting theory and interpretation of data; radioactive measurements; radioactive spectrometry; low level counting; instrumentation — selection and limitations; instrumentation needs.

Members of the Dresden technical staff, responsible for instructing and training other personnel assigned to the plant, were given a three-day program in instructing techniques. This course, presented by the Education and Training Division of the Commonwealth Edison Company, consisted of a lecture-workshop.

Field Training

Training assignments in this category are intended to provide work situations paralleling an individual's plant assignment or simulating his job duties. Such assignments require the application of theoretical knowledge and associated experience to actual work performance.

Commonwealth Edison has obtained this type of training at the facilities of US AEC Argonne National Laboratory and Hanford Atomic Products Operations, and the General Electric Company's Vallecitos Boiling Water Reactor. Under the US AEC's work experience program, contracts were made to train the chemical engineer and the radiation protection engineer for six weeks in the ANL Chemical Engineering Division-Reclamation and the Health Physics Division, respectively.

The chemical engineer gained experience and knowledge in the following activities: decontamination-protective measures, work on small and large equipment, work on machinery; construction and design of special storage and handling equipment and special supplies; liquid waste disposal-collection, analysis and disposition; solid waste disposal-collection, handling, baling and storing.

The radiation protection engineer received on-the-job training in health physics.

A similar contract with US AEC at Hanford Atomic Products Operations, provides the radiation protection engineer with a six weeks' full-time assignment in the Health Physics Department. Here experience is gained with equipment and methods applicable to power stations.

Hanford Atomic Products Operations is an excellent facility for obtaining maintenance experience in a nuclear environment. Their operations provide repetitive opportunities for maintenance personnel to observe maintenance situations and techniques. The work experience contract here provides on-the-job training in the following areas:

Development and use of maintenance procedures; protective clothing and uses; remote handling and procedures; marking, modifying and using tools; decontamination of tools and equipment; welding and welding methods; machine shop and machine shop practices; plastics and their use in confining and limiting contamination; maintenance of reactor and reactor controls.

Commonwealth Edison assigned the Dresden Station maintenance superintendent and two maintenance foremen to Hanford for six weeks, for full-time training and experience.

Desirability of training reactor operators at facilities having reactors as much like Commonwealth Edison's boiling water reactor as possible naturally led to programs at General Electric's VBWR and at Argonne's CP-5 reactor and EBWR.

The training program at GE's Vallecitos Boiling Water Reactor is arranged to qualify assigned trainees for US AEC licensing examinations, upon completion of the following study and work:

History and description of VBWR; test program for VBWR; safety procedures at VBWR; design of VBWR, its operation and instrumentation; electric power generating equipment, components and operations; general plant start-up; refueling components and procedures; demineralizer equipment, operation and maintenance; reactor flux and power measurements; radiation protection procedures and methods; operating practice, using operating procedures, including (a) reactor operations during start-up, (b) reactor operations during maneuvering, (c) reactor operations during shutdown, (d) participation in reactor fuel changes.

Dresden's assistant superintendent, supervising engineer, nuclear engineer, five shift engineers, and 14 operators will require US AEC operators' licenses for performing their duties in Dresden Station.

Assignments of personnel for training are proportioned between ANL and VBWR with respect to training time available at these facilities and the date trained individuals will be needed at Dresden Station. In all cases assignments are at least eight weeks in duration, full-time participation.

Fig. 6. Nuclear fuel unloading procedure is practiced by Dresden trainees

Operator training started in November, 1957 and will continue into June of this year. At that time all individuals to be licensed will have had on-the-job experience at ANL or VBWR or, in some cases, at both facilities.

In-Plant Training

In-plant training provides instruction and practice in the specific activities of each plant employee, at the job site. Supervisors, manufacturers' representatives or other qualified personnel work with trainees until they can satisfactorily perform the aspect of work under instruction.

An in-plant two-week training course for management personnel, operators and engineers, who did not take the course in Dresden Station Technology, provides a general familarization with details of plant design. It is instructed by the technical staff.

A course in radiation protection is given to all employees of the plant. Thirty hours of classroom instruction are given by the radiation protection engineer or a member of his staff.

Five weeks of full-time instruction and demonstration are programmed for the course in instrumentation and control. Instructors are qualified manufacturers' representatives and the instrument engineer. All of the instrument mechanics in the instrument and control group require this training. Theory and actual application are provided as follows:

Instrumentation systems, components and functions; tests and test equipment; types and applications; amplifiers — types, components, circuits and utilization; amplifiers — calibration and maintenance; dc energy sources — types, circuits and utilization; dc energy sources — adjustments and maintenance; vacuum tubes and transistors — types, characteristics and applications; connectors — types and utilization.

Most extensive course in the training program deals intimately with each and every piece of equipment in the plant. Detailed text material, drawings and diagrams, put together in a five-volume equipment description manual, is the basis of a course titled Dresden Station Equipment Description. All personnel of the plant, except the clerks, guards and janitors receive essential plant information through this classroom and demonstration course. Two to four weeks are required.

Operator's License

One of the most important segments of the training program is the study and preparation for the US AEC operator's license examination. At Dresden, as previously indicated, a total of 22 individuals must be licensed.

Meeting license requirements involves knowledge of and practice on the reactor the operator will control.

At the onset, the applicants of Commonwealth Edison will be instructed by General Electric representatives and the Dresden technical staff. After the plant goes into commercial operation, Dresden's shift engineers, technical staff and licensed operators will provide the training.

Some of the present training courses will be expanded and changed as new requirements become evident due to changes in installation or procedures.

Other courses, yet to be developed, relate mainly to specific operating procedures. These courses will cover the following activities: initial fuel loading; power operations; plant start-up procedures; plant shutdown procedures; refueling; routine testing; emergency procedures.

Status of Training

At the present time 24 employees have completed all of their training except part or parts of the Dresden Station equipment course and the seven procedures under development. They are now at the site familiarizing themselves with the physical plant and systems now installed, and assisting in the preparation of the remaining procedures and working with General Electric employees wherever their talents and skills can be utilized.

The training plan has operated very smoothly since its initiation in 1957. Changes have been mainly the variation of dates of entry into some of the specialized training courses in order to take advantage of work situations that offered greater scope.

The training program is expected to operate even more smoothly as time goes on because the balance of the work involves the use of Dresden's own personnel and the station itself as the training site. THE END.

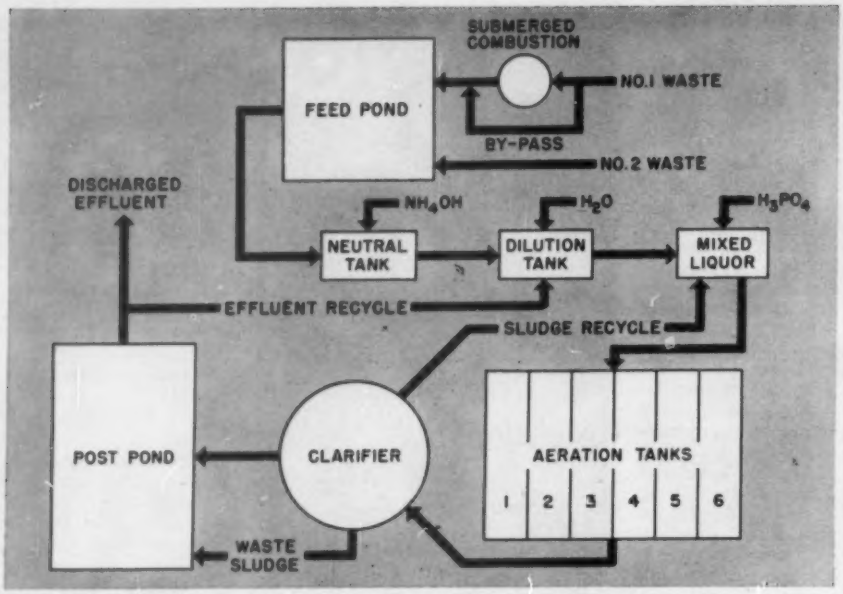


Fig. 1. First unit in the new waste treatment plant is the submerged combustion burner (Fig. 2)

Combustion and Bio-Oxidation Combined in Waste Plant at Chemstrand

Pensacola plant prevents pollution of Escambia River by new procedure for treating hard-to-handle nylon wastes. Stepped-up production rates required a whole new approach to wastes treatment

By D. T. LAURIA *

IN LATE 1955, the Chemstrand Corporation nylon plant at Pensacola, Florida, found itself facing the need of adequate facilities for treatment of waste that would be produced at proposed 1957 expanded production rates. If the expected wastes should be discharged untreated, their biological oxidation in receiving waters would lower dissolved oxygen to the point where aquatic life would suffocate.

As a result, treatment was seen to be necessary to remove organic constituents. Waste production before expansion did not require treatment, because control through use of retention lagoons was sufficient to hold pollutants within safe receiving water assimilation limits. After a long period of study and design, a complete waste treatment system was constructed, and the facilities are presently being used to prevent pollution of the Escambia River.

For some of the waste streams, treatment design was relatively simple; but for others, extensive pilot study was necessary. The nylon waste that is treated comes from the manufacturing area where cyclohexane, one of the raw materials from which nylon is made, is oxidized to form adipic acid. In producing nylon, a portion of adipic acid is reacted with ammonia to form adiponitrile which, in turn, is hydrogenated to form hexamethylene diamine. Diamine, an organic base, is neutralized with the unused portion of adipic acid to form "nylon salt." The salt is then polymerized in the yarn plant and is extruded as yarn, cooled, drawn, twisted, and wound on bobbins for shipment to consumers. Approximately 88 per cent of the waste comes from the manufacture of adipic acid, while the remainder is distributed among the other process steps.

Three Types of Waste

Nylon wastes are divided on the basis of physical properties into three categories. Portion of the waste is so concentrated that it is burned for recovery of usable heat. This is done in the power plant where the waste is atomized and used with natural gas as an auxiliary fuel to heat the boilers.

A second waste stream is disposed of by incineration in a closed-type brick structure which consists of a floor and four walls lined with heavy duty refractory, a steel roof, and a short stack for discharge of combustion gases. Along the inside front wall of the incinerator are four burners which extend from small recessed wall spaces. These spaces, called plenum chambers, have air ducts running to them, and they are the points at which primary air enters the structure.

Burners consist of two concentric rings of flame jets. Liquid waste and steam for atomization are piped to the inner jets where the mixture is converted to a fine spray. Natural gas is piped to the outer circle of jets. Besides primary air which is supplied mainly for combustion of the natural gas, secondary air is piped through ducts and enters the incinerator at several points along the side walls. This air is used for combustion of the waste stream when the flow of primary air is insufficient.

In starting up the incinerator, a flow of natural gas is put through the burners, and the primary air compressors are turned on. The combustible mixture is ignited, and this serves as a pilot light. When the desired temperature is reached in the incinerator the waste and steam flows

* Sanitary Engineer, The Chemstrand Corp

Fig. 2. Combustion unit can process material at 125 gpm

Fig. 3. Pond receives burner effluent, mixes with other waste

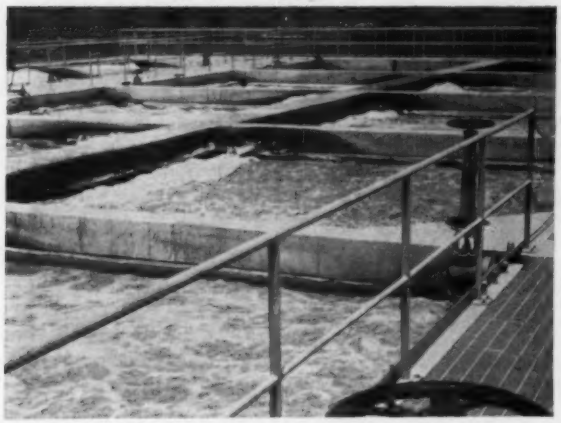


Fig. 4. Aeration detention in these tanks is about 12 hours

Fig. 5. Mixed liquor then flows to 70-ft-diam settling tank

are started. The intense heat in the unit raises the waste temperature to the flash point, and combustion takes place. The natural gas flow is not turned off then but is kept on to maintain a minimum operating temperature so that there will be complete incineration of the waste.

Disposal of these two streams did not involve the detailed pilot studies which were necessary to design the plant to treat the third waste.

This third "stream" is actually composed of waste from several sources, and it is made up of by-products and a small percentage of lost process material.

Problem of process development and treatment plant design was solved after approximately one year's work. During that time, consultants were employed to assist in developing design criteria from pilot plant and laboratory studies. After development work was completed, the same consultants were again contracted to design the treatment plant.

Main features of the process that was developed for treating dilute wastes are: 1. submerged combustion, used to treat the volatile portion of the waste from adipic acid manufacturing; and 2. activated sludge bio-logical oxidation, used to treat the remaining dilute streams and the effluent from the combustion unit. Other features included in the system are: two lagoons for waste storage; neutralization, dilution, and mixed liquor tanks; and a circular clarifier for sludge-liquid separation.

Submerged Combustion Burner

First unit in the waste treatment plant is the submerged combustion burner. Approximately half the treatable waste (the volatile portion) goes to this unit, which consists of a 1600-gal stainless steel evaporation vessel and stack, a bustle where air and natural gas are blended to form a combustible mixture, a burner pipe which extends from top to bottom of the evaporation vessel with a flame jet submerged below the waste surface, and valves, piping, and instrumentation necessary for operation.

When the unit is running, waste enters the evaporation vessel at its midpoint (Fig. 6). Effluent then flows by gravity through a line at the bottom of the vessel. A high loop in the effluent line maintains desired liquid level in the evaporation vessel. The mixture of air and natural gas is ignited by an electrical resistor at high temperature, the velocity of flame propagation being high enough to overcome the static head of waste so that liquid cannot back up in the burner tube. The hot gases from combustion heat the waste to the boiling point, and vapors leave the unit through the stack.

Various safety features have been incorporated so that back-fire or explosion cannot occur. Feed rate to the unit is approximately 100 gpm. Evaporation losses range from 30 to 40 per cent, and BOD reduction is about 70 per cent.

Bio-Oxidation Plant

Effluent from the submerged combustion burner flows to a 29,000,000-gal lagoon, where it is equalized with remaining raw process waste. The mixed waste is then pumped at about 700 gpm to the first unit of the activated sludge plant, the neutralization tank. Ammonium hydroxide is added to the waste, to act as a nutrient and to adjust the pH to the slightly alkaline side.

The neutralized waste then flows to a dilution tank, where it is mixed with river water, treated bio-oxidation effluent, or a combination of both. The conditioned waste is then

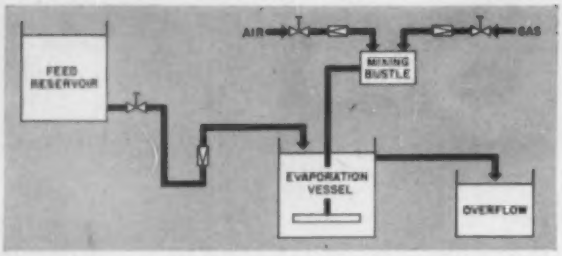


Fig. 6. Schematic of submerged combustion burner pilot unit

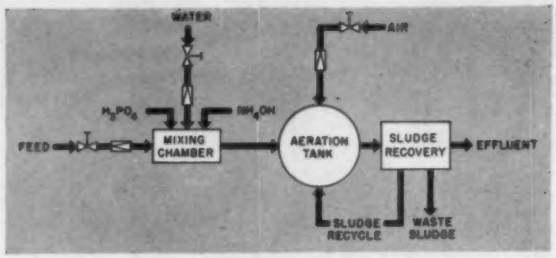


Fig. 7. Schematic showing plan for bio-oxidation pilot plant

mixed with active sludge organisms recycled from the clarifier, and the mixed liquor flows to aeration tanks which have a total volume of nearly 2,000,000 gal.

Approximately 12,000 scfm of air is supplied to the mixed liquor to satisfy high sludge respiration rates and to maintain aerobic conditions. Theoretical aeration detention is 12 hours, after which time the mixed liquor flows to a 70-ft-diameter circular settling tank, where the heavy sludge floc settles to the bottom and is drawn off to be mixed with raw influent waste. Clarified effluent overflows a V-notch weir at the top of the unit and goes to a post treatment lagoon before discharge to the river.

The bio-oxidation unit started operation in October, 1957, and since then several conditions which affect efficiency have been varied so that their results could be noted. Organic loading (lb BOD applied/lb sludge) was investigated from 0.3 to 4.0; mixed liquor suspended solids was varied from 800 to 3000 ppm; aeration detention was changed from 8 to 12 hours; and recycled effluent for waste dilution was increased from 0 to 100 per cent of the diluent. BOD reduction varied from 80 to 95 per cent, with maximum at loading of 1.0 and aeration detention of 12 hours. Sludge respiration rates varied from 20 to over 200 lb O_2/hr/lb sludge and sludge volume index changed between 20 and 800 ml/gm.

Besides the submerged combustion and bio-oxidation units, and incineration, other treatment facilities are used to dispose of domestic wastes.

Treatment facilities at Chemstrand have successfully prevented pollution of the Escambia River. Daily physical, chemical, and biological analyses of the river by Chemstrand and by the Philadelphia Academy of Natural Sciences have shown that the waters are in good condition.

But the fact that Chemstrand's waste treatment system is presently doing a satisfactory job does not mean that no effort is being made to do an even better job. Two drum-scale activated sludge control units have been in operation since March, 1958, so that information on variables which affect process efficiency can rapidly be obtained. Before a serious change in operation conditions is made, it is first tried in the control unit so that, in case of failure, the efficient operation of the full-scale unit will not suffer. Laboratory work is also being performed to determine the effect of various factors on activated sludge operation. THE END

Utilities Do Affect Plant Site Selection!

ATTRACTING NEW and holding old industry is a most worthy endeavor for an electric utility organization. In many cases, it is an absolute requirement. Particularly does this hold true in distressed areas where, due to a change in the basic economy of an industry, components of the industry have moved to new locations. This was most forcefully pointed out by P. L. Richardson in a paper presented at the annual meeting of ASME in New York.

Richardson, who is Power Contract Consultant Supervisor for E. I. du Pont, stressed the fact that most manufacturing companies, whose primary interest is in the manufacture of specific products and not the generation of electric power, prefer, with few exceptions, to purchase all electric requirements. As an example of this attitude, du Pont depends exclusively on purchased electric power in 63 out of a total of 75 manufacturing plants. In only two plants are all electric power requirements met by in-plant generation.

While there are many physical, economic, and other intangible factors which determine where a new plant will be built, the following considerations were enumerated by Richardson as being of specific importance in site-selection for new manufacturing facilities: 1. combination supply of steam and electric services on a co-operative basis; 2. importance of quality of electric service; 3. rate consideration; and 4. utility effectiveness on site studies.

Quality of purchased electric service is a subject to which increasing attention has been devoted over the past several years. Quality of purchased power available at a proposed new site may even transcend in importance the economics dictated by the heat balance considerations involved.

Increased complexity and automation of highly complex manufacturing operations (as, for instance, a synthetic fiber plant) demands the ultimate in quality of purchased electric service. The term *quality*, in this instance, relates to continuity of voltage and frequency as well as freedom from unexpected outage.

Richardson further observes that in some site studies where substantial blocks of purchased power may be involved, differences in costs of purchased power may easily be one of the determining factors affecting management's ultimate decision. Some utilities may find it desirable to explore possible modification of existing industrial rate structures in order to attract industries. Such modifications are often desirable where a potential industry has a high load-factor characteristic.

Many electric utility organizations have found that, to be most effective insofar as attracting new industry is concerned, their area-development functions need to be invested in an individual, usually a high corporate officer, who can speak with authority and make commitments of a steadfast and binding nature for the utility involved.

Richardson concluded that the utility industry should seek manufacturers that selectively fit local conditions; take a long-range view on system design and improvements to continually upgrade service quality; seriously consider the advisability of offering related utility commodities; establish fair tariffs and respect confidences.

Sub-metering Locates Electrical Waste, Helps Correct Low Power Factors

By HAROLD F. CROTTY *

INFORMATION on the amount of electrical power used in manufacturing sub-components is mandatory to determine operating efficiency and to assign accounting costs. Such data can be best obtained through the use of sub-metering installations where watt-hour and reactive-voltampere-hour (varhour) meters accurately measure the electrical energy required by each specific manufacturing section.

Thus, unusual energy conditions existing in any sub-unit will be made known and corrections may be undertaken to effect a possible solution.

In every industrial plant where electricity is a vital requirement of the business, the electric utility will usually record and bill for the total energy and the power demand. Oftentimes, the plant may have its own metering installations to double check the energy and to provide means of local demand control. Demand refers to the amount of power taken by the customer and is usually measured over an interval such as 15, 30 or 60 minutes of time. Generally, electric rates include a charge based on the maximum demand as well as the billing for kilowatt-hours of energy.

Overall registration of energy does not pin-point a location where power is being inefficiently used. For example, consider a specific department operating large induction motors not fully loaded, which results in a low power factor and inefficient use of generated power. This condition showing inefficient use of generated power would be reflected adversely in the demand rate billing. Sub-metering would point out the existence and location of such conditions so appropriate corrective action could be initiated.

A typical 3-wire, 3-phase metering installation consists of a watthour meter, a varhour meter with its phase-shifting transformer and possibly several instrument transformers, depending on the load current and voltage rating. (Self-contained meters would be used up to 480-volt and 200-amp ratings, and two current transformers for over 200 amperes. Above 480 volts two potential transformers would also be required.)

Controlling the Demand

As an example of where sub-metering could have been of considerable value, but was not employed, a large manufacturing plant was billed on a kwh basis, plus a monthly charge for maximum kw demand. The demand charge of $4500 ran approximately one-third of the monthly $13,500 bill for kwh consumed.

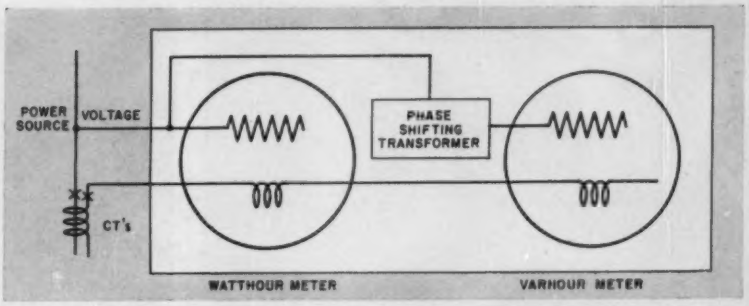


Fig. 1. One-line wiring diagram for two-meter station with current transformers

When several equipment changes were made, the demand charge increased $500 in one month, or approximately 11 per cent. Meters were checked, and found to be accurately calibrated. A meeting of sub-component managers was held, and a series of cut-and-try experiments was begun, staggering known loads in an attempt to reduce the maximum demand charge.

Plant power factor was maintained around 90 per cent through the use of compensating condenser units.

When at length the demand charge was returned to nearly its former level, there was no assurance that electrical operation was at peak efficiency, nor could it be assured that the new schedule was in the best interests of the plant. In this case sub-metering the various departments would have removed this confusion, and pin-pointed the difficulty as soon as it occurred.

Departmental Allocation

A second example concerns a large manufacturing plant where sub-component metering is used. Here every section has its own meters to record power and demand. Every month a member of the electrical department reads the meters and sends the data to the accounting section. Electrical charges are allocated to each component, and excess use of electrical energy is quickly detected.

Whenever additional machinery is added, the meters in that component will show an increase. Decisions on adjusting time schedules for conditions of exceptional power use may be readily made from the available metering data. In this way, the charges for electricity may be held to a minimum. These results not only help the manufacturer, but also aid the utility who must supply the maximum power at any time that it is required.

In addition to being extremely advantageous in the locating and controlling both the excess use of power and the source of poor power factor, sub-metering fits very well into the modern management concept of budgeting and controlling costs at the foreman level. Basic to the success of this system is that there must be no mystery about the costs charged to the foreman's account. There must be no arbitrary assessments or allocations of pooled expenses.

If costs charged to the foreman must be a result of recognized measurements, and must meet the test that action on his part to improve his operation will correspondingly be reflected in his reported financial results, sub-metering will prove a boon, indeed almost a necessity, to this cause.

The cost of a sub-metering unit varies with the installation. An approximate net fixture may be calculated as follows:

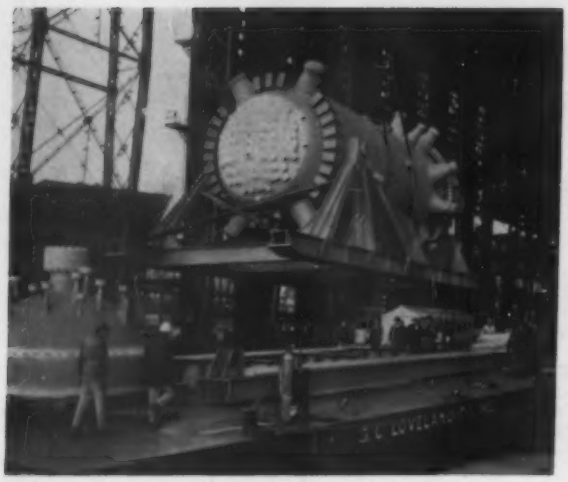
1. Self-contained sub-metering unit consisting of one polyphase kwh meter, one similar kvar meter with a phase-shifting transformer, all mounted in a polyphase duplex socket. Approximate net price, $121.00.
2. Transformer-rated sub-metering unit, consisting of two meters and a phase-shifting transformer and two 600-volt window-type CT's 400/5, all mounted in a ployphase duplex socket. Approximate net price, $183.00.

All watthour and varhour meters may have indicating or accumulating demand registers for maximum demand registration. As an alternative, a contact device may be located on any polyphase meter to operate a separate demand meter. Meters are available for switchboard applications if desired. Demand meters can be equipped with alarm devices for demand control to prevent excessive demand charges.

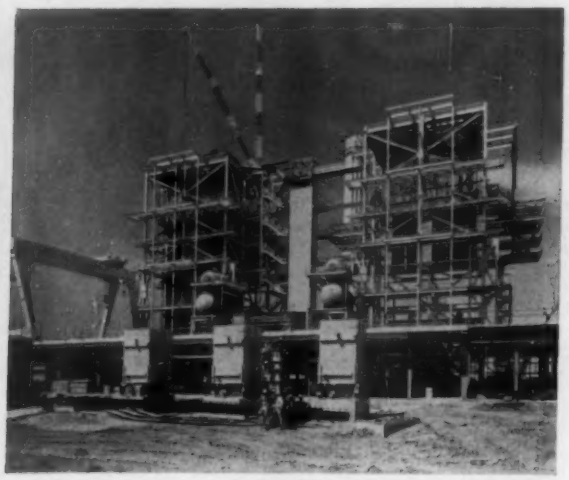
Sub-component metering determines the efficient usage of electric power, and is extremely helpful in assigning accounting costs for each manufacturing component. THE END

* Application Engineer, General Electric Co

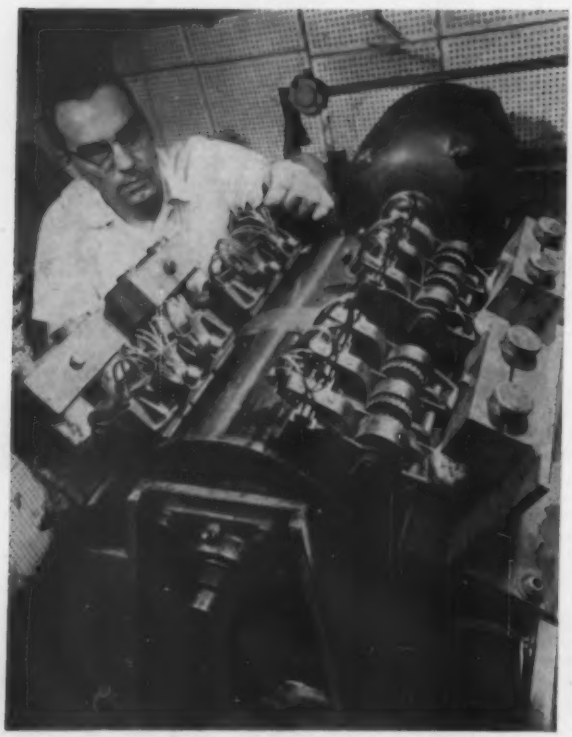
POWER ENGINEERING'S



Biggest nuclear power reactor vessel is this 300-ton unit made by New York Shipbuilding Corp for Commonwealth Edison's new Dresden Station (see page 76). Vessel is 42 ft high, 20 ft wide, has walls 5½ in. thick. It will go from New Jersey to its Illinois site by sea and inland waterway



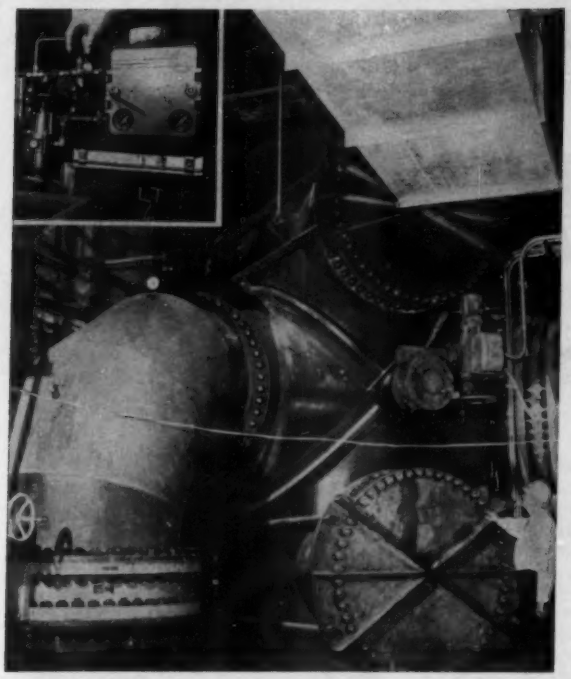
Piercing the sky above Mandalay Beach near Oxnard, Cal, are the giant steel girders of Southern California Edison's $57,000,000 Mandalay Steam Station, scheduled for completion this year. Conversion of sea water to fresh will be done here in a pilot plant equipped by Cleaver-Brooks



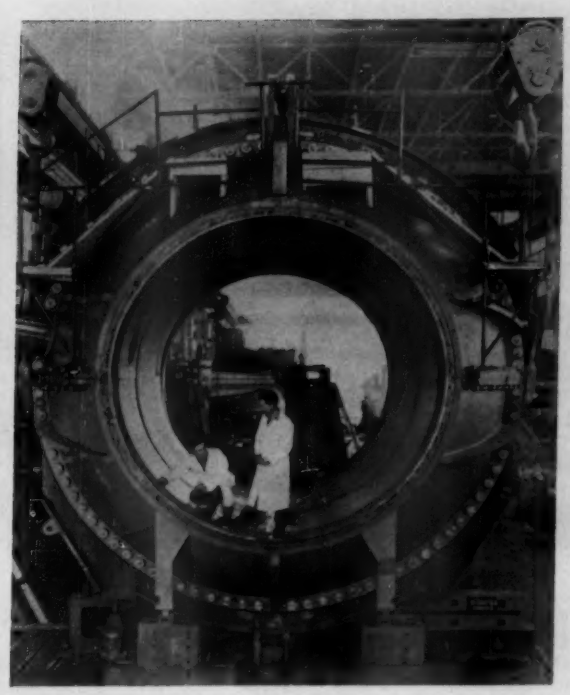
Nearly 450,000 bumps an hour on this special test rig give carbon brushes a beating they'll never encounter in normal service. Used by National Carbon Co, the cylinder simulates a motor's commutator, rotates at 1750 rpm. The carbon brushes slam hard against it 7000 times a minute

9 ft deep, 37 ft long and all-aluminum, this huge bottom-dump hauler is one of six leased from Alcoa by Squaw Creek Coal Co to move coal to a tipple where it will be processed for eventual use in Alcoa's Warrick, Ind, power plant

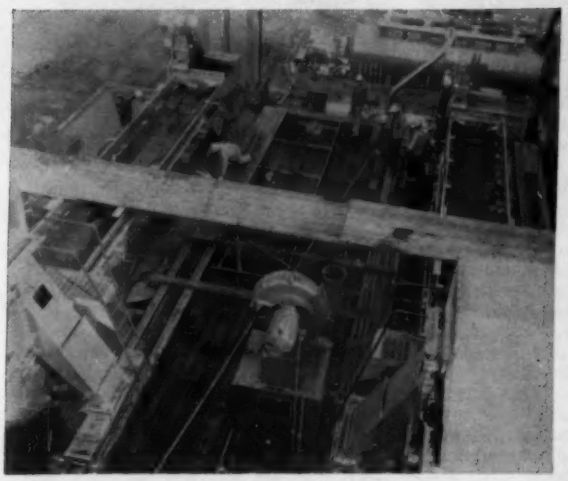
NEWS REEL



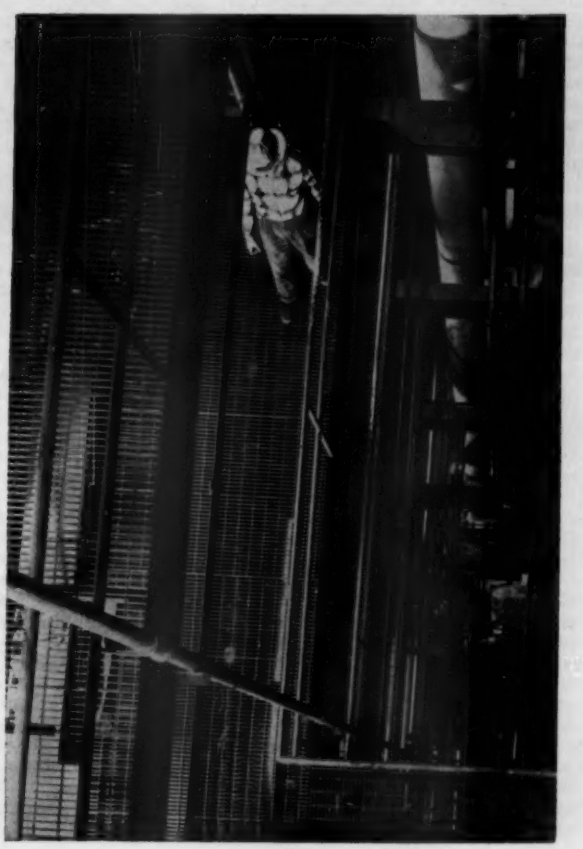
Over 8000 valves, from 5-ft-diam reversing valves (above) to ¼-in. instrument valves (inset), have gone into the Thos. H. Allen Electric Generating Station at Memphis. Cost—$1,500,000, or about 1¼% of the $121,000,000 plant



Smooth-bore valve for a hydro-electric scheme connected with the St. Lawrence Seaway has 12-ft bore and 22½-ft diam. Five of these will control turbines rated at 180,000 hp. They are being made in the Toronto plant of John Inglis Co



Snow removal system is built into tripper deck over the coal bunkers of Cherokee Station of Public Service Co of Colorado. Designed by Ebasco, system uses hot water mixed with anti-freeze, heated by steam exchanger and circulated through 1-in. wrought iron piping embedded in 5¾-in. concrete



Man walking up a wall? No, it's a view from above of the Blaw-Knox electro-forged grating used for open flooring and stairways in a big power station in Illinois. Grating has twisted bar surface, improves visibility and ventilation

Fig. 1. View of Dayton Power & Light Co's Frank M. Tait Station during alterations for new 130,000-kw units Nos. 4 and 5. Construction is semi-outdoor in type, and for the first time by an electric utility in this country, Sulzer monotube boilers are being used. Fill areas for ash are shown top left

Tait Station Expands Ash Handling System

By L. E. MYLTING *

IT WAS JUST over 40 years ago that Miller's Ford Station of the Dayton Power & Light Co was placed in operation. Combined capacity of the first two units was only 25,000 kw, but this represented what was then the best of the scientific developments of the industry.

Early last summer, the first of two 130,000-kw units being added to the generating equipment of the station (renamed the Frank M. Tait Station), brought it up to a temporary 280,000 kw; another 130,000 kw will be added within the next few weeks.

Like the historic event of four decades ago, this addition also represents the most recent developments in the field: the new units — Nos. 4 and 5 — mark the first use of the Sulzer monotube boiler by an electric utility in this country.

Tait Station's new units 4 and 5 have rated capacities more than double that of the largest existing turbine generator of the entire DP&L system. Steam generators for these units are designed to deliver 940,000 lb of steam per hr to the turbine throttle at 2400 psig, 1050 F with reheat to 1000 F. General arrangement of heating surfaces is not essentially different from those in the many controlled-circulation boilers now in service. Corner firing using tilting tangential burners is used.

For the power industry generally, the growth of Tait Station presents an outstanding case study of how one utility is keeping up with the continuing demands for more and more electric energy. A particularly interesting aspect is their solution to the problems of ash removal.

This solution is based on the replacement of a pneumatic system with a more economical hydraulic system — a replacement which took place in 1951. The system that was then installed, by Allen-Sherman-Hoff, served four steam generators for existing units 7 and 8. These were 30,000-kw turbine generators operating at 1200 psi with associated high pressure boilers.

Ash handling for these existing units 7 and 8 has been identical. Bottom ash from the two furnaces serving each unit is collected and stored between sluicing periods in steel plate, insulated hoppers.

A pool of water is maintained in the hoppers to quench clinkers and slag falling from the furnace. Contact with the cool water disintegrates or tends to make the large pieces brittle by thermal shock. This quenching water is maintained by waste cooling water from other equipment.

Ash is removed from each hopper through piston-operated, vertical lift gates into stepped concrete sluiceways equipped with nickel-iron liners. Water jets wash the ash from the hopper.

Sluiceways are very short, discharging ash and water to a pump sump, located between each pair of hoppers. An 1800-gpm centrifugal-type Hydroseal ash pump moves the ash from the sump, through 8-in. Ashcolite piping to a valve nest at the eastern side of the plant, where it is routed to either of two lines going to nearby fill areas.

Fly ash is collected at 12 points on each furnace. Air-electric operated materials handling valves remove the fly ash from hoppers beneath the points of collection. It is then conveyed pneumatically through a 4-in. conveyor pipe system to jet pumps which produce the vacuum and mix the fly ash with water, and the fly ash and water are discharged through an air separator tank by gravity to the valve nest and thence to fill.

Each pair of steam generators has its own jet pump, but both pumps discharge into a common air separator tank. Segregating valves isolate the sections of vacuum conveyor lines to confine the vacuum to the working area, thus increasing the vacuum and handling rate. Two sequence control cubicles located in the mill room control the discharge at all points of collection.

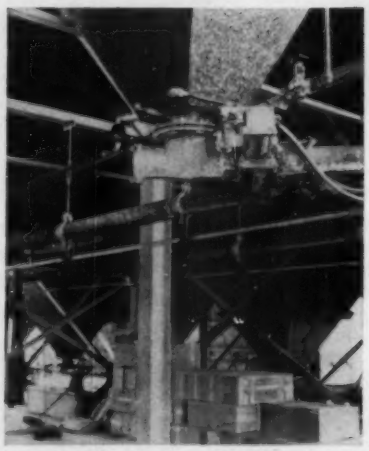


Fig. 2. Air-electric materials handling valves control removal of fly ash

System Changes

As part of the present expansion at Tait Station, this ash handling system has now been revamped to accommodate the top and bottom ash from the two new boilers. By revamping the piping and control panels, and by the addition of interlocks and switches, the same control boards, though relocated, will be able to handle the ash from the two new boilers as well as the four existing ones in a

* Vice president in charge of engineering, Allen-Sherman-Hoff Co

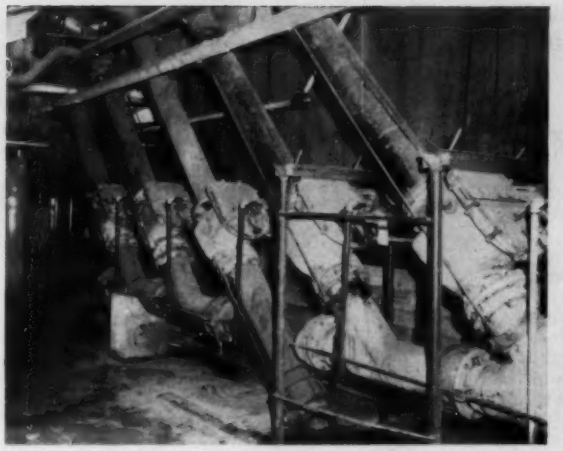


Fig. 3. This valve nest routes ash and water discharge to fill areas. Fly ash is collected in hoppers at 18 points on each of the units and then is discharged into 4-in pipe system

Fig. 4. Between sluicing periods, bottom ash is stored in multiple feed plate hoppers. Hydraulic pistons open vertical gates to sluiceway. Water jets help wash ash from the hopper

system as completely automatic as is practical.

Bottom ash is collected in a system similar to that for units 7 and 8. Like the other hoppers, these new ones are Ashfrac-lined; unlike the others, they are the end-outlet type.

Ash and water discharge through cylinder-operated gates into a nickel-iron-lined sluiceway. This sluiceway discharges to a pump sump located between the two hoppers; provision has been made for the possible future addition of a clinker grinder — differing from the other sumps now installed.

Ash pump discharges 1800 gpm through 8-in. Ashcolite pipe against a static head of 9 ft, 9 in.

Eight pyrites mills (four for each unit) discharge through 6-in. push-pull operated slide gates into sluice which empties in turn into the pump ash sump. (No pyrites arrangements were included in the existing systems for units 7 and 8.)

The 8-in. Ashcolite pipeline joins the valve nest where ash and water are routed to the fill area.

Fly ash is collected in hoppers at 18 points on each of the units and discharged through air-electric operated materials handling valves into a 4-in. conveyor pipe system. Air-electric operated valves segregate that section of the line actually being used. Vacuum is produced by jet pumps, one for each unit, discharging into a common air separator tank. Ash and water mix go to fill via the valve nest.

Because two lines to fill were in existence, and with complete coöperation of all suppliers, it was possible to make all piping relocations and install the new units without the necessity to shut down any unit of the system.

The automatic sequence controls have been relocated and altered to handle the new units.

Relocation of the ash handling control, along with the modernization of the system to accommodate the new units, and the overall automation added to the old plant permits a more efficient use of operating manpower. Addition of this equipment has released enough manpower from the old plant so that no additional men will be needed to operate the new units.

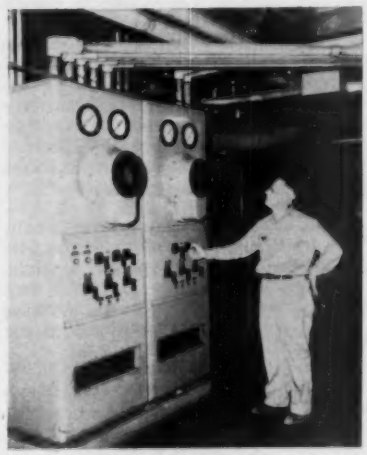


Fig. 5. Over-all automation for the ash handling comes from these controls

History of Expansion

It is interesting to look back over the history of the Tait Station and see the various stages that have led up to the station's present size.

In 1915, the company decided to build their first big electric generating station, one that would incorporate the latest scientific developments in power production. For this purpose a site was purchased at Miller's Ford, about two miles south of the city of Dayton.

Construction of the Miller's Ford Station was begun in 1916. In March, 1918, the first two units were placed in operation; their combined capacity was only 25,000 kw. By 1928 the capacity had been increased to 110,000 kw; by 1940 it was 170,000 kw. During the 11-year period from 1940 to 1951, expansion and modernization brought the total installed generating capacity up to 220,000 kw.

During and after World War II, it became evident that it was impractical to expand the Miller's Ford Station to supply the increasing needs of Miami Valley. An entirely new station was built just 10 miles downstream, and named in honor of Orie H. Hutchings, a pioneer in the industry and a vital personality in the development of the company. The Miller's Ford Station was renamed the Frank M. Tait Station, to honor the chairman of the board.

In the planning for the new Hutchings Station, experience with pneumatic ash handling at the Miller's Ford Station was weighed against the to-be-expected advantages of hydraulic handling. DP&L engineers became convinced that wet handling would be more efficient, and the original plan was written to specify a hydraulic system to serve the six proposed units.

Dayton Power & Light Company's experience with wet ash handling at Hutchings Station proved extremely encouraging. During the first six months' operation, performance had met or exceeded the design data. So it was a logical decision that one of the first steps in modernizing Tait Station in 1950 should be the replacement of the existing pneumatic ash handling system with a more economical hydraulic system.

Last step in the Tait expansion has been the company's present decision to retire the station's three oldest, smallest units and replace them with the two highly efficient 130,000-kw units. THE END

New operating economies, higher standards of reliability result as authorities and manufacturers coöperate in a continuing effort

Britain Modernizes World's Largest Grid Control System

By ROBIN WALKER

THE CENTRAL Electricity Generating Board's electricity supply system, the Grid, is the largest system under unified control in the world. It consists of 260 power stations with an aggregate capacity of 2,000 mw (30 million hp) and 350 main electricity distributing centers, (Grid switching stations).

All of the electricity system is connected together through the Grid and is operated as a unit so that the power stations that can generate most cheaply are used to the maximum extent and the power stations where the cost of generation is higher are used as little as possible, thereby keeping down the cost of electricity to the consumer.

Grid Control Centers

To achieve this coordinated operation, there are for England and Wales seven Grid Control Centers, each in direct communication with all the power stations and main switching points in their area, and a National Control in London which is in direct communication with those Grid Control Centers which are situated at Newcastle, Leeds, Manchester, Birmingham, Bristol and two near London.

During the full 24 hours of every day, this system control organization is checking costs of generation, planning generating programs and issuing instructions for generating plant in power stations to be started up or shut down so as to meet the constantly changing demand for electricity at the lowest possible overall cost.

To do this with ever increasing efficiency, the original Grid Control Centers that have existed for 20 to 26 years have recently been superseded by modern Centers embodying all the latest techniques and apparatus using communication and indicating equipment of a standard type throughout the whole country.

Standardized Equipment

Earlier Grid Control Centers and the stations within their areas were equipped in the early 30's with several different systems of telephone telemetering and general indication equipment. These systems used rented Post Office circuits radiating from the Control Center via city trunk exchanges.

Experience during the war and immediately afterwards showed that there was great need for a readily-extensible system using standardized equipment. Accordingly, in 1949 it was decided to re-equip the Grid control networks and to build new and larger controls in more suitable districts and where they would be independent of city trunk exchanges.

The British Electricity Authority and the telephone manufacturers concerned — the Automatic Telephone and Electric Co, Ltd, The General Electric Co, Ltd, and Standard Telephones and Cables, Ltd — together set up a Telecommunications Technical Committee (TTC) to design and produce a "standardized system" of equipment which would provide the additional facilities required.

In the final result, under TTC direction, each firm developed and produced its own particular contribution towards the standardized equipment, while the installation in the stations and in the Grid Control Centers were shared on a geographical basis.

New communication networks continue to use rented Post Office circuits, but the more distant stations are now connected in groups of two to four stations and reserve tie lines are provided between major stations.

Control Facilities

More important facilities given by the standardized system are as follows:

1. Direct calling telephony between Grid Control and the stations, and between stations. As continuously available communication is essential, and to guard against temporary failures, there are at least two communication routes into each major station or group of stations. Inter-station telephony is also provided.

2. Transmission of continuous meter readings from distant stations for display at the Grid Control Center up to a general maximum, which in some instances is in excess of 20 simultaneous readings over one Post Office circuit, all unaffected by speech or signals traversing the same line.

3. Transmission of signals from stations to the Grid Control Center where they are made to record automatically the position (open or closed) of any Grid circuit breaker at remote stations.

4. Sending of generation instruction and routine telegraph messages from the Grid Control Center to the stations.

In each of the new Grid Control rooms there is the following:

1. A mosaic switching diagram upon which all switching operations are recorded, the circuit breaker positions being shown automatically.

2. A feeder flow diagram where telemeters show how power is flowing through various transmission lines of the Grid.

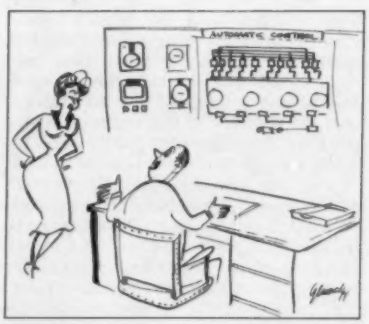
3. Switching desks equipped with keyboard answering and priority calling of all stations within the area, and from which switching instructions are given and permits-to-work issued.

4. A loading desk with similar telephone keyboards, together with the routine telegraphs, generation instructors and an indication of the load being generated by each power station. From this desk, the generation of power is continually regulated in accordance with the requirements of the consumers and of economy in operation.

Conclusions

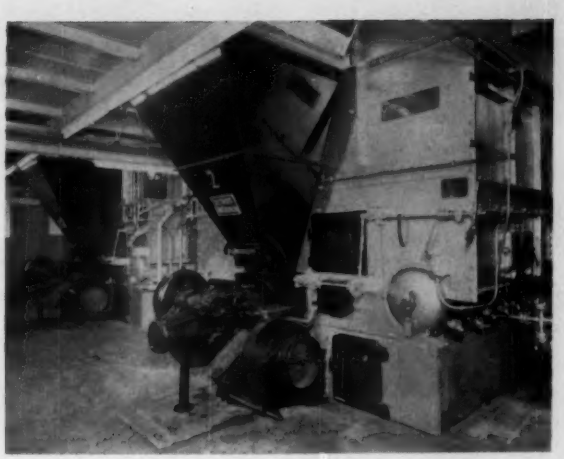
The standardized system is now in full operation in all control areas of The Central Electricity Generating Board and the benefits of standardization and of co-operation between the manufacturers, the Post Office and the Board are abundantly clear. Without this co-operation, the re-equipment program would have been impossible on both practical and economic grounds.

Although some time must elapse before the new National Control network is completed, operational experience has been most gratifying in those control areas where the standardized system has been in operation for several months. THE END



"Heavens, Marie, get it out of your head that we're replacing you with a machine!"

Modern heating boiler is typical of Detroit public schools



Heating systems in public schools need boilers with high availability factors. With over 400 boilers in the system, planned replacement is of utmost importance. Here's how Detroit does it

How Detroit Schools Replace Boilers For Safety and Efficiency

By JOHN L'HOTE*

FEW INDUSTRIAL CONCERNS can match the potential hazards of a situation such as is found in the Detroit School System where 441 boilers are in operation each day of the heating season in, or adjacent to, school buildings housing over 280,000 children. The Detroit Board of Education, consequently, has reason to be proud of the fact that no child has ever been injured by a boiler accident and that difficulties requiring schools to be shut down have been extremely rare.

In 1929 an agreement was reached between the Board of Education and the Department of Buildings and Safety Engineering, of the City of Detroit, upon a program of replacing boilers as they reached thirty years in service. Since that time no school has had a boiler condemned as unfit for future service. Inspections, however, frequently disclose defects requiring repairs before the boiler can be returned to operation. Only the replacement program, in addition to our continuing programs of inspection and repair, has allowed us to avoid explosions and other failures that would require major repairs and would result in closing school buildings until repairs could be made.

Infinite number of variables affecting the life of a boiler makes it impossible for anyone to judge with certainty the number of years that a steel boiler can be expected to remain in service without requiring replacement. City of Detroit Bureau of Safety Engineering, however, bases its boiler regulations upon a reasonable expectation of thirty years of safe operation, provided that repairs are made as they are found to be required by an annual internal boiler inspection.

At the end of thirty years, and each three years thereafter, their regulations require that each boiler be stripped so as to expose all seams and joints, and that a hydrostatic test be applied. If this test shows the boiler to be in satisfactory condition it may be retained in service, subject to annual internal inspections, for another three years.

In recent years, appropriations of $250,000 to $300,000 annually have been necessary to cover the cost of replacing boilers and associated equipment reaching thirty years of age. This associated equipment includes pumps, tanks, fuel burning equipment and the like, which deteriorate at a rate equivalent to that of the boilers.

In the face of increasing labor and equipment costs, and the attainment of the thirty-year age by the great many boilers installed during the large school building program of the 1920's, this amount is no longer proving to be adequate for the program.

At the present time we have more than one hundred boilers that have passed thirty years in service. The Board of Education has, consequently, been requested to budget so as to provide approximately $1,000,000 annually for a seven year period following July 1, 1959. This amount would be adequate to replace boilers at a rate that would bring our program back to the thirty-year cycle by July 1, 1966, and allow the appropriation to be cut back somewhat at that time.

It is possible, of course, that some of the older schools planned for inclusion in this program might be taken out of service before their boilers are replaced. Offsetting this possible financial advantage is the fact that we have made no specific provisions for the replacement of heating plants in sixteen smaller schools heated by cast iron boilers or hot air furnaces Cast iron boilers are not included in this replacement program because the nature of these boilers is such that they are not affected by corrosion to the extent that makes the thirty-year replacement of steel boilers advisable. On the other hand they are very vulnerable to shock and one instance of too rapid heating or cooling might destroy a boiler and force its immediate replacement.

More Than Boilers Are Involved

Annual amount of money involved is admittedly very large, but it must be recognized that it represents only an average annual replacement appropriation of about three per cent of the total replacement valuation of our boiler room equipment.

It should also be noted that the replacement costs involve modernization, as well as direct replacement of equipment, and that our history of nearly thirty years of periodic boiler replacements has demonstrated that the advantages obtained are many and varied. Among them may be noted:

1. Maintenance of our "production" of school days, year after year, almost without interruptions caused by heating plant failures.
2. Gradual elimination of the types of boilers that have created the greatest air pollution nuisances.
3. Savings in cost of the maintenance of boilers, boiler room equipment

*Supervising Engineer, Board of Education, City of Detroit, Mich.

Table showing boiler types, modernization costs and results obtained by replacement program in Detroit public schools

School	Aver. annual fuel cons. before boiler change	Aver. annual fuel cons. after boiler change	Annual reduction in tons	Percent reduction	Years new plant has been in service	Type of equipment* installed	Total cost of plant modernization
Angell Elementary	350	224	126	36	7	F.B.	$ 67,312
Cooper Elementary	376	301	75	20	4	F.B.	76,538
Ellis Elementary	267	207	60	22	9	F.B.	52,520
Harms Elementary	220	150	70	32	5	W.T.	65,320
Keating Elementary	432	372	60	14	4	F.B.	72,754
Longfellow Elementary	458	337	121	26	5	F.B.	79,659
Marxhausen Elementary	302	218	84	28	7	F.B.	81,707
Maybee Elementary	250	170	80	32	5	F.B.	78,052
Russell Elementary	471	320	151	32	9	F.B.	63,630
Scripps Elementary	163	107	56	34	10	Ec.	41,595
Stephens Elementary	361	273	88	24	9	F.B.	54,696
Trombly Elementary	209	177	32	15	4	F.B.	75,663
Wilson Jr. High	314	224	90	30	6	F.B.	66,770
Northeastern High	1363	891	472	34	10	W.T.	114,635
Northern High	1752	1203	549	31	8	W.T.	132,867
Northwestern High	3192	2565	627	20	8	W.T.	173,703

Total amount of coal consumed by the above schools annually:

Before boiler replacement	10480 tons per year
After boiler replacement	7730 tons per year
Total savings	2741 tons per year
Average reduction	26.2 percent

*W.T.—Water tube boilers
F.B. —Firebox boilers
Ec. —Economic boilers

and their associated accessories.
4. Savings due to elimination of the costly hydrostatic tests required on old boilers remaining in service.
5. A bonus in fuel cost savings that has averaged over 25 per cent as indicated on the table of typical results. These savings are the result of replacing brick-set HRT boilers and V-grate overfeed stokers, with firebox firetube, or low head water tube boilers fired with underfed stokers. It should be pointed out that the savings are not only a result of combustion efficiency but of improvements in condensate control, and similar measures.

Coal Most Economical Fuel

Although the Detroit Board of Education is currently operating boilers fired with natural gas and with #5 oil, as well as with coal, and is heating small areas with light oil and electricity, the boiler replacement program has been, thus far, based upon replacing obsolete and oil-fired equipment with modern coal-fired equipment. This decision has been based upon several factors:

1. Coal provides the lowest unit fuel cost in this area.
2. Buildings being converted are all presently provided with coal storage areas.
3. Our operating procedure seldom provides an opportunity to save labor by a change in fuel selection.

High cost of the individual boiler room modernizations shown would seem to warrant some explanation. An explanation might best be given by a description of one of the replacements. The Longfellow School project is typical:

1. Removed three existing HRT boilers and V-grate stokers; 136, 120 and 115 boiler hp respectively.
2. Installed two new high pressure 143 boiler H.P. (1430 sq. ft. h.s.) firebox boilers with underfed stokers.
3. Installed complete new complement of boiler auxiliaries, including piping, valves, blow-off tanks, pumps and the like.
4. Installed new storage water heater and summer hot water boiler for domestic hot water.
5. Installed new sump and sump pumps.
6. Removed obsolete water-operated ash elevator and installed new electric hydraulic ash elevator.
7. Provided complete new condensate return system in adjacent fan room including traps, valves, strainers, and the like.
8. Modified condensate return system in a remote fan room to correct chronic troubles.
9. Installed electric heaters in conservatory to take care of week-end heating.

As indicated upon the data sheet, this work cost the Board of Education $79,659.

Direct savings in labor and fuel can be computed and amount to about $3,000 annually. Important difference between the cost of servicing obsolete thirty year old equipment, and the negligible cost of maintaining the new equipment, is another sizeable cost factor that can be added to this but is almost impossible to calculate.

Maintenance of our educational production and the added safety for the children are undoubtedly the most important results of the program, in any event, and these evaluations are in terms of humanistic values and are beyond the scope of our engineering staff. THE END

REPRINTS OF VALVE MANUAL

A series of articles on basic valves used in the power field has been running in POWER ENGINEERING for the past several months. This series has now been completed and we have prepared a complete reprint called the Power Engineers' Valve Manual. Since this series of articles was written by recognized experts, we feel this is one of the most authoritative treatises on valves yet to appear.

Single copies of the Valve Manual are available to our readers free of charge UNTIL MAY 31; AFTER THAT DATE, REGULAR PRICE OF $1.00 WILL PREVAIL. Simply write us on your letterhead requesting a copy. Those of you who have already requested copies need not write again; your requests will be filled automatically. Quantity lots are available at minimum cost. Our production department will be glad to quote on such quantities.

Power Engineers' Valve Manual covers the basic types of valves. Although there are hundreds of different styles, all are modifications of the types covered in the manual. This is an essential piece of literature to every power engineer's library.

Fig. 1. Failure of turbine rotor triggered this turbine oil fire. Now look at Figs. 2 and 3 to see the end result

Fire hazards, never things to be taken lightly, become more serious as installations grow ever larger. This excellent article will help you re-evaluate your protection system

How Good Is Your Fire Protection?

By R. A. MACDUFF*

SUBSTANTIAL INVESTMENTS of time, capital and engineering talent are required before a modern power station goes on the line. Trend toward larger stations places many eggs in a single basket. A serious fire can cause the loss of the investment, in addition to the losses resulting from reduced generating capacity.

While it is not intended to convey the impression that a generating station is a potential bomb waiting to explode, it should be noted that all the elements for a fire are present. Results have been impressive. A National Fire Protection Association report, which deals only with fires resulting in losses exceeding $250,000, lists three fires for the year 1957. Losses reported do not include many smaller fires, or so-called intangible losses, or side effects resulting from down time or reduced generating capacity.

During the 1945–1954 period, the latest period for which a report has been issued, the N.F.P.A. reported generating plant fires with damages exceeding $7,000,000, and resulting in the death of eleven men. Damages reported do not include the losses suffered by both utility and customers due to loss of generating capacity.

For fire protection purposes, the steam generating plant can be divided into three general areas:

1. Fuel supply and associated equipment necessary to deliver fuel to the boilers.
2. Turbines, generators, and internal oil systems.
3. Transformers and oil circuit breakers necessary to the distribution of the generated power.

With the exception of the fuel handling equipment, atomic power plants would have basically the same hazards.

Hydro-electric plants do not have the combination of oil and high temperatures found in steam generating plants. Internal plant fire hazards are, therefore, not the same.

Generators in hydro plants are usually protected. Protection is either water spray or carbon dioxide. A water spray system, consisting of nozzles supplied by a pipe ring, is installed inside the generator, and the system is triggered by fixed temperature thermostats. Water is discharged directly on the fire.

When carbon dioxide is used to protect hydro-plant generators, a double ring of piping and nozzles is installed inside the unit. Two banks of carbon dioxide cylinders are used, an initial and a delayed discharge bank. When the system is tripped, the initial bank is discharged, flooding the generator with a concentration of carbon dioxide sufficient to extinguish the fire. A delayed discharge bank is also actuated and, through restricted piping and orifices, maintains the concentration of carbon dioxide during the generator's deceleration period.

In addition to the generators, oil rooms, paint shops, and other areas containing flammable materials are protected by water spray systems or carbon dioxide installations.

Fuel Supply

Fuels most commonly used for power generation are coal and oil.

Oil, when used as a fuel, is stored in tanks located a reasonable distance from the plant. Tanks are surrounded by dikes, and fire protection, when provided, consists of a fixed foam installation.

Chemical foams, as used prior to World War II, have been largely replaced by mechanical foams in which foam is produced by mechanical agitation of a mixture of 97 parts water and 3 parts foam compound or stabilizer. Mechanical foams are more easily stored, proportioned, and distributed. Briefly, the foam system consists of a control house, or center, where the foam compound (a brownish protein base liquid) is proportioned into the water stream and a system of distribution piping. Proportioning equipment is fairly simple, consisting of metering orifices or devices which utilize a venturi to maintain the proper proportions over a predetermined range of flows.

Solution of water and compound is routed to the proper tank by means of the piping system and flows into the tank through one or more foam makers located on the side of the tank just below the top. Through mechanical agitation in the foam maker, air is aspirated into the solution and the resulting foam flows out over the surface of the oil, smothering the fire. This protection is usually manually controlled.

Protect That Coal Conveyor

Coal conveyor is the vital link between the coal storage and the generating station. Loss of the conveyor system, unless duplicate facilities are provided or an alternate source of fuel is available, means loss of the station's generating capacity.

Principal causes of conveyor fires have been belt misalignment or seized pulleys, with resulting friction igniting the belt. Belt usually burns in two and results, at best, in loss of the belt and a badly damaged conveyor structure requiring extensive repairs or perhaps replacement.

Due to the physical configuration of coal conveyors, the most practical means of protection is afforded by a deluge water spray system. Water spray will quickly extinguish the fire, thereby preventing collapse of the structure or spread of the fire to other sections of the conveyor or to the bunkers. Early detection of the fire is necessary. Therefore, the protection should be automatic.

* Contracting Engineer
The Grinnell Co.

Fig. 2. In addition to mechanical damage, fire at left collapsed steel trusses and dropped 6000 sq ft of concrete roof

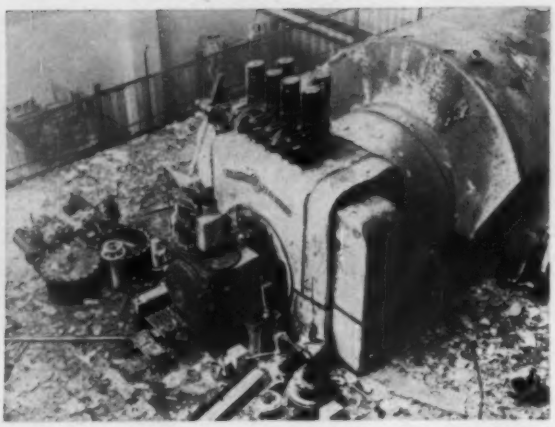


Fig. 3. Oil leak in thermometer well adjacent to superheated steam line started it all. Resulting loss was catastrophic

Bunker rooms are best protected by good housekeeping and a deluge sprinkler system installed under the roof. Considerable thought has been given to the extinguishment of bunker fires, but very little has actually been done in the way of effective installation. Most promising scheme is one which advocates saturating the bunker with carbon dioxide and maintaining the concentration by slowly bleeding in more CO_2 over an extended period of time. Actual tests have been made of this system with promising results.

Turbine Oil Hazards

Modern power stations require large quantities of oil to lubricate bearings and operate governor equipment. Large oil quantities handled require storage tanks, purifying equipment, pumps, settling tanks, and distribution piping. A piping system distributing oil in quantity and under pressure, if interlaced with super heated steam lines, introduces the requisites of a fire.

Turbine bearings can, and do, become worn after constant use and leak oil until a considerable amount has soaked into the lagging of adjacent steam pipes. In areas where steam temperatures exceed 550F these conditions can result in fires. Protection should be installed. Bearings can be protected by either a water spray or a dry chemical installation. When water spray is installed, a ring of nozzles surrounding the bearing is piped to a water supply. Fixed temperature thermostats are installed to either trip the system automatically or to sound an alarm to notify the operator that the system should be manually activated.

Dry chemical bearing protection is installed in much the same way. A ring of nozzles surrounding the bearing is piped to a nitrogen pressurized 350 pound or 500 pound dry chemical extinguisher. An alarm system is provided to warn that trouble exists and to point out the location. Upon notification of a fire, the system is manually tripped, and the fire quickly extinguished.

System can be arranged for intermittent discharge to give several shots, thereby protecting against reignition. This is always a distinct possibility with fires of this nature. When the initial extinguisher becomes exhausted, a portable dry-chemical unit can be quick-coupled to the fixed piping and the system continued in action.

A bearing fire occurred during 1956 at a steam generating station in Pennsylvania. Fire was quickly extinguished by activating the fixed dry chemical protection. Unit was not taken off the line and the fire re-ignited five hours later, whereupon a second shot of dry chemical was used to extinguish the fire.

Turbine Oil Reservoir

A potential source of fuel for a fire is the turbine oil reservoir which may contain several thousand gallons of oil. Reservoirs are usually located on the basement floor, although in some cases they are suspended above the floor and surrounded by a grating or platform.

Adequate protection for turbine oil reservoirs can be provided by deluge water spray systems. Tank is protected by a ring of directional nozzles so located as to provide direct impingement of water spray on the top and sides of the tank. Where the tank is suspended above the floor, the area under the tank should also be protected. With either the floor mounted tank or the suspended tank, consideration should be given to curbed areas to contain any spilled oil. Adequate drains should be provided to carry away both oil and water.

Should a turbine oil reservoir rupture, it is probable that sufficient oxygen would be admitted to permit oil to burn inside the reservoir, out of reach of the water spray system. Fires of this type can be extinguished by a carbon dioxide system designed to render inert the interior of the reservoir. Such systems are usually activated by a fixed temperature thermostat.

Seal oil units can be protected by either CO_2 or water spray. Water spray will not extinguish burning hydrogen. It will cool the area, prevent further damage to the equipment involved, as well as adjacent equipment, and prevent spread of the fire. Carbon dioxide which will extinguish the fire has also been installed in these areas.

Oil leaking and burning in a generating station will quickly reach the basement level and continue to burn. Extinguishment of this oil can be accomplished by a deluge water spray system designed for general area protection. Where protection has been designed for the turbine oil reservoir, seal oil unit, and other areas, this system can be designed to cover the remaining unprotected areas.

To be assured of extinguishment, a deluge water spray system must be designed to discharge water, in spray form, at uniform density, over a given area. Drop size must be large enough to allow the spray to reach the surface of the oil. A water density of .25 gpm per sq ft of floor area is generally regarded as being adequate for extinguishment.

Importance of adequate drainage has been stressed several times. Where adequate drainage facilities do not exist, and cannot be provided, fire protection must be designed accordingly. Foam extinguishing systems can function in areas where poor drainage prohibits the use of a water spray installation. Foam system has the advantage of requiring less water (.16 gpm per sq ft). Holding that water in suspension, and dropping it out over a period of several hours, enables limited drainage facilities to cope with the disposal problem.

Water spray systems used in power plants are of the deluge type. This means that all nozzles or projectors

Fig. 4. Hydro stations have hazards too. This resulted when oil-immersed disconnect switch ignited a governor oil leak

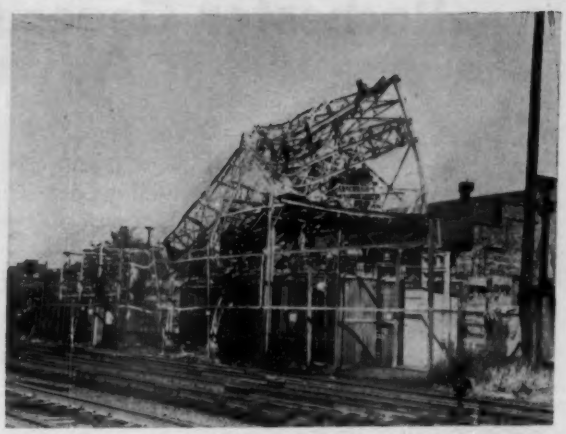


Fig. 5. Lightning strike caused this. Both the transformer and the overhead bus structure suffered extensive damage

are open, and when a system trips, water sprays from all the nozzles on that system. Quantities of water involved might vary from 300 gpm to 1500 gpm or more.

First few seconds of any fire are universally regarded as being the most crucial. Effective steps taken during the early stages of a fire will, more often than not, result in quick extinguishment with minor fire damage. From a fire protection standpoint the automatic system is, therefore, the most effective. Many utilities feel, and justly so, that before deluging a station with large quantities of water, the station operator should be given the opportunity to appraise the situation, since it is his responsibility to keep the station on the line. With this in mind, many water spray systems are designed with zoned alarm systems to detect the fire and notify the control room. Water spray systems are equipped for remote manual actuation by electric push button, pneumatic impulse, pilot line, or other means. The station operator receives the alarm, appraises the situation, and activates the system protecting the area involved.

Transformers Are Vulnerable

Transformers are costly, compact pieces of equipment filled with flammable oil, subject to fires caused by lightning, winding breakdown, internal and external shorts, bushing failure, and "unknown cause". Where the transformer is located close to the station wall, as many are, the hazard is two-fold. Possible loss of the transformer is augmented by the possibility of extensive structural damage to the adjacent wall.

Transformers are protected by fixed pipe deluge water spray systems. Nozzles are supported and fed by a pipe ring which surrounds the transformer. Pipe rings can be self-supporting or attached to existing steel or nearby walls. Flanged pipe sections in the ring facilitate removal of the transformer that is involved.

Arrangement of the nozzles is such that the top and all vertical surfaces of the transformer are covered with water spray. Ground in the immediate vicinity of the transformer is also protected. In addition to those on the pipe ring, additional nozzles may be required under obstructing radiators, tap changer boxes, under the case, or other protrusions. Where the transformer is located adjacent to the station wall, care should be taken to completely cover the space between the transformer and wall with spray. Oil spurting from the transformer can burn in this area and cause considerable damage, if protection is not provided.

Transformer fire protection requires an adequate supply of clean, fresh water under sufficient pressure to discharge it from the nozzles at spray forming velocities. Nozzle pressure required can vary, depending upon the nozzle used, from 20 psi to 100 psi or more.

Automatic actuation is almost mandatory to enable the fire protection to knock down a transformer fire during the crucial first few seconds. An automatic detection system can be one of several proven methods, such as electric thermostat, pneumatic rate-of-rise, wet or dry line pilot sprinklers. The automatic system can also be tripped by impulse from the transformer fault relay. There are numerous cases of transformer fires which, due to automatic actuation, were extinguished by the time station personnel reached the transformers.

Carbon dioxide, while excellent for indoor transformer vaults, has the limitations of quick dispersion and limited supply, which restrict application for outdoor transformer installations.

Accounts are available of many fires on both protected and unprotected transformers. Unprotected transformers are invariably severely damaged, and usually are a total loss. Protected transformer damage is usually limited to that caused by the fault which initiated the fire. A case in point would be a recent fire which involved a protected transformer at an eastern utility. A 100 mw transformer failed at 11:45 p.m., and was involved in a fire which was immediately extinguished by a water spray system that had been installed about ten years earlier. The system was automatically actuated by fixed temperature thermostats. Unit was returned to service at 6:30 a.m. the following morning.

Unprotected Transformer Fire

Contrast this with a fire this year involving an unprotected transformer which had been installed but eight months. When the fire, fed by oil spurting from the pressure relief vents, was finally extinguished damage approximated $250,000. Case for transformer fire protection is strengthened by these and many similar fires.

While it is not meant to dismiss protection for oil circuit breakers lightly, they are not protected as often as other equipment. When protection for oil circuit breakers is furnished, the system is similar to that used for protection of transformers.

Importance of portable fire fighting equipment, although not covered in this article, should not be minimized. The station should be equipped with adequate hand hose stations, and with both hand or wheeled dry chemical, or carbon dioxide extinguishers.

Finest fire protection available is of no value if not properly used. Importance of an adequate training program to familiarize the station personnel with the proper maintenance and application of the equipment cannot be over-stressed.

Modern power plants are larger, more complex, and more expensive than their predecessors. Continued operation is vital to our economy. Value and importance of the equipment involved makes it imperative that every reasonable precaution be taken to protect investment. Fire protection is reasonable. THE END

Rochester Generating Station Features Advances in Piping Design

Today's challenge to central station designers lies in utilizing larger capacity units resulting from higher pressures and temperatures without radically increasing space requirements. Computers play a prominent role in solving problems thus imposed

By B. R. WHEELOCK, Jr.*

WITH COMMERCIAL operation of Unit No. 4, the Russell Station of Rochester Gas and Electric Corporation has reached its ultimate anticipated capacity of 215,000 kw total nameplate power generation rating. This was attained by the addition of the last unit rated at 75,000 kw.

In anticipation of the growing need for electrical power in this area, Rochester Gas and Electric Corporation held ground breaking ceremonies for Unit No. 1 in December, 1946, and thereby started construction of a power plant that is not only modern and highly efficient but has a building and grounds that have won national distinction. Unit 1 was placed on the line in December, 1948. Shortly afterward Unit 2 was started. It was placed in operation in December, 1950. In October, 1953 Unit 3 was placed in operation, and a little more than 10 years after breaking ground, Unit 4 was ready for operation.

During this period the art of power plant design and engineering experienced considerable improvement. Turbines and boiler units of greater capacity became available with practically no increase in space requirements over earlier designs. Unit 1 was rated at 40,000 kw with main steam design conditions of 1250 psig and 955F. Units 2 and 3, both rated at 50,000 kw, were designed for 1500 psig and 1000F main steam conditions with 1000F reheat. Unit 4 with a controlled circulation boiler unit occupying only slightly more space than each of the two previous units, has a rating of 75,000 kw with 1875 psig and 1050F main steam design conditions and 1000F reheat steam.

For all four units, Gilbert Associates, Inc. acted as consulting engineers and designers in cooperation with the engineering staff of Rochester Gas and Electric Corporation. Blaw-Knox Company's Power Piping and Sprinkler Division, Pittsburgh, Pa., furnished and erected piping and pipe supports for all four units.

Fig. 1. Two 14 in. high temperature reheat lines divide from the 18 in. main. In this photo, vertical 18 in. cold reheat line, center, hides the main steam line

A New Stress Analysis Method

One of the advances in the art of power plant engineering took place a short time before starting the design of Unit 4. This was the development by the Blaw-Knox Company of the 6 x 6 Flexibility Matrix method for stress analysis of intricate piping configurations using a high speed electronic computer. Among the first to realize the advantages of this system of stress analysis were Rochester Gas and Electric Corporation and Gilbert Associates, Inc. The method was used, therefore, in the stress analysis of the major piping for Unit 4. The relative speed with which this method accomplishes complex calculations enabled the engineers to obtain values for the forces, moments, deflections, rotations and stresses of the preliminary piping layouts at an early stage in the engineering work. With this information it was then possible to clear the design at an early date and place the order for the alloy pipe material.

Shop Fabrication Pays Off

Same general arrangement of piping layout was maintained for each of the four units. However, the greater complexity of Unit 4 piping required a more compact design. Blaw-Knox followed the piping drawings of the engineers in shop-fabricating all piping sized 2½ inches and larger. This resulted in fast, accurate

*Mechanical Engineer, Gilbert Associates, Inc.

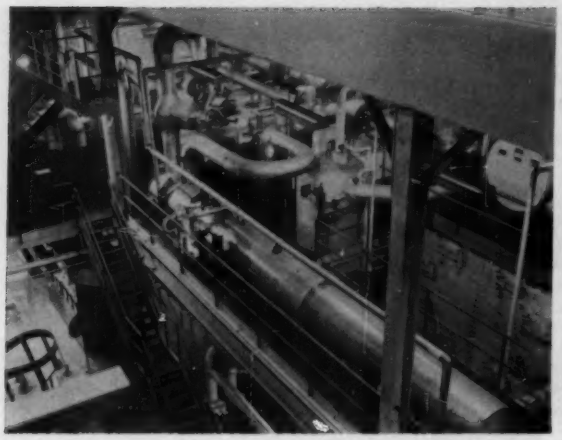


Fig. 2. Feed heater shown uses sixth stage extraction steam. Vertical piping at far end is boiler feed discharge line

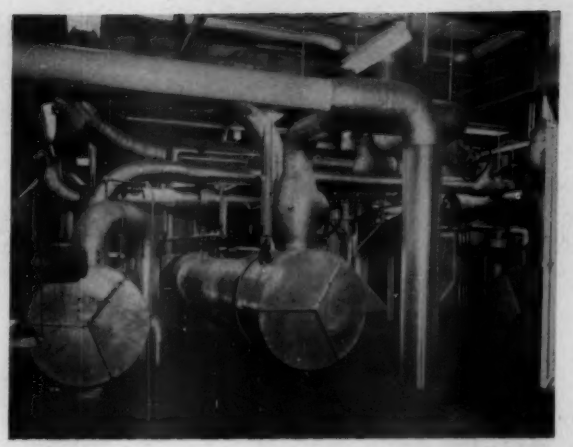


Fig. 3. This view of the feed water heater bay shows complex arrangement of the extraction steam and feed water piping

piping installation as done in the field.

All pipe supporting material was furnished by the Blaw-Knox Company. Pipe hangers for the major piping were designed by the engineers. The remainder of the required support designing was done by the piping erector.

Russell Station has several features that are noteworthy. Visitors are usually impressed first by the exceptionally clean stacks. Rochester Gas and Electric Corporation is using the best means available to remove fly ash from the stack gases. A barely discernible emission indicates that the plant is operating.

Inside the building, the four units were designed to follow the unit system. Each is separate as far as the steam, feedwater and condensate circuits are concerned. An efficient coal handling system supplies all four units with bituminous coal which is pulverized prior to feeding into the boilers. Electrical switchgear bay is located indoors below the operating floor level between the boiler room and turbine room. This rather unconventional location minimized the length of electrical leads to the major pieces of equipment.

Boilers for Units No. 2, 3, and 4 incorporate the floating header design. Flexibly supported superheater and reheater headers absorb much of the vertical expansion of the pipe risers. In this way pipe requirements for the highly expensive alloy main and reheat steam piping were minimized.

Main and Reheat Steam Piping

Piping of Unit No. 4 installation was checked with a Steelscope prior to erection to assure that specified alloy piping material was installed in the required locations. This portable instrument identifies alloy steels quickly on the job and provides Blaw-Knox Company's Power Piping and Sprinkler Division with another check to insure a piping system that meets all service conditions.

Main steam piping for Unit No. 4 is 2¼ per cent chrome, 1 per cent molybdenum hollow-forged alloy steel material. There are 145 feet of this pipe which is 14 inches in outside diameter with 2.125-inch (min.) thick walls. This divides into twin turbine leads that are 8⅝ inches outside diameter.

High-temperature reheat steam piping is 1¼ per cent chrome ½ per cent molybdenum longitudinal welded alloy material. There is a total of about 300 lineal feet of this pipe which includes 18-inch OD pipe with 0.703-inch (min.) wall running from the reheater outlet header and dividing into two pipe lines that are 14 inch OD and have 0.586-inch (min.) wall. They were designed for 412 psig at 1005 F.

Low-temperature reheat steam line from the turbine to the reheater inlet header is carbon steel conforming to ASTM Specification A106, Grade B. Two 12.75-inch OD lines with 0.375-inch wall form a single 18-inch OD line with 0.375-inch wall. A total of 283 feet of pipe is used in these lines. An additional 70 feet of piping in two 12-inch pipe lines from the turbine converge into the 18-inch line. These lines operate at 425 psig and 700 F. THE END

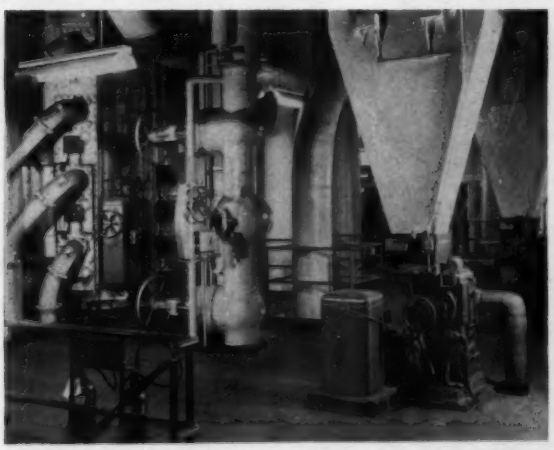


Fig. 4. Boiler feed discharge piping with three valves is seen at left. Center vertical run is 14 in. main steam

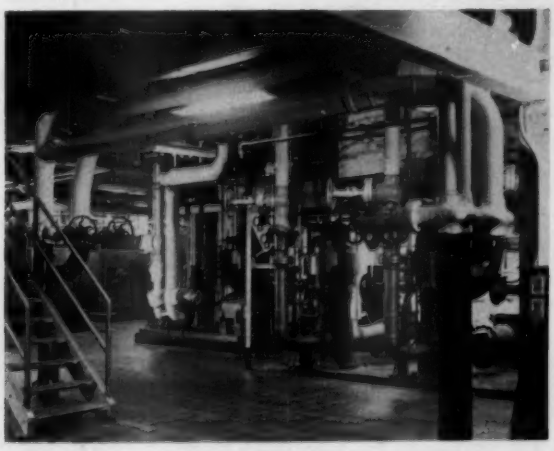


Fig. 5. Condensate pumps take suction from the condenser hot well and discharge through 6 in. line to generator coolers

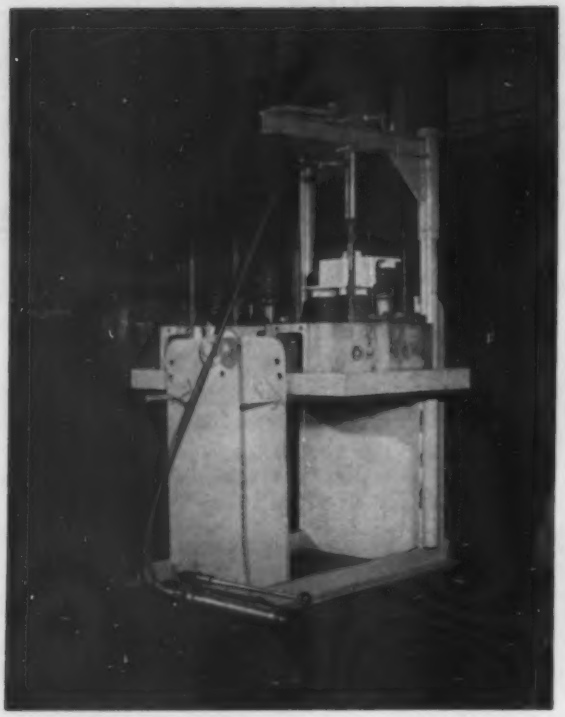


Fig. 1. Cylinder-head fixture holding two 300-lb diesel engine cylinder heads positioned for removal of valve springs

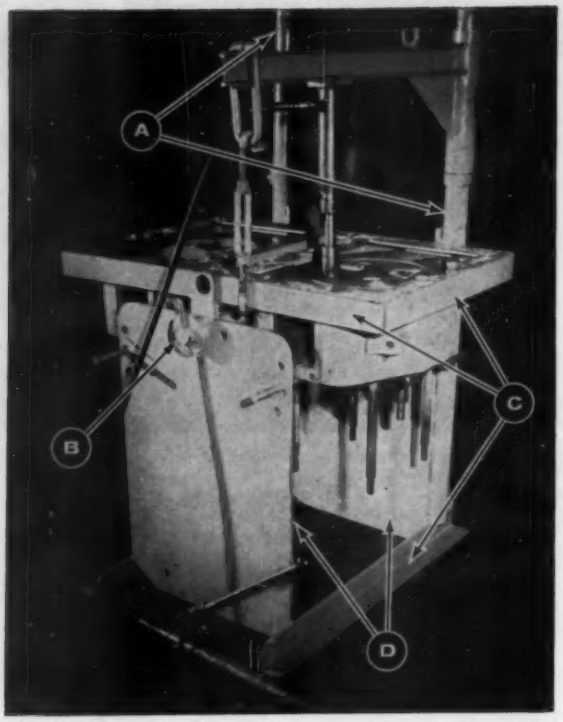


Fig. 2. Same jig with heads inverted. A. 3-in. pipe. B. (Axle) 1½-in. pipe. C. 3 by 3 by ¼-in. angle. D. ¾-in. steel plate

Good Handling Fixtures Slash Diesel Maintenance Costs

By L. J. BRASHER*

A STUDY of the movement of materials and parts of equipment undergoing repairs in most maintenance shops will disclose great opportunities for improvements in one or more of the methods being used in these movements. Frequently the study will indicate corrective action or additional improvements in the repair operation itself.

Observation of the movement of a component of a machine, vehicle, engine or other apparatus that is to be repaired begins at the time the disassembly is started.

In all repair operations there is a movement of parts of this main complete assembly, piece by piece or sub-assembly by sub-assembly. This movement follows definite paths and directions dictated by shop layout; that is, locations of cleaning equipment, inspection and gaging stations or benches, machine tool operations, if any, and rebuild and re-assembly stations.

In between the dis-assembly, inspection, cleaning, machining, and finally re-assembly lies a fertile field of possible improvements in one of the steps involved in this cycle or in the movement of new parts from stock or spares in kind that may be used in the cycle. New bolts, screws, pipe fittings, fasteners of all kinds, all are moved from certain locations as the cycle is presently organized.

How much this can be changed or improved by a proper detail study and record of each movement of each piece and movements of the hands, body and feet of the repair man or operator depends upon the advantages that become obvious and logical from such a study.

Room for Improvement

As an example of possibilities in this field, a study of repairs to large cylinder heads of a locomotive diesel engine were made. Leading up to the decision to study this particular item were many irritating facts. These were disturbing from a material handling or time study and efficiency viewpoint.

Observations of the movement and repair of these heads disclosed a need for improvement, viewed in the light of current possibilities in the design and use of switch jigs and fixtures. Highly developed know-how is available in the application of material or parts handling equipment to increase efficiency.

In the first place, these cylinder heads are box shaped and weigh 400 pounds each. Secondly, they are the first heavy pieces to come off the engine after the valve covers and rocker boxes are lifted off. Third, the head assembly consists of four large valves, with eight springs, four spring caps, and eight assemblies composed of four keepers and locks, as well as four valve guides that are pressed into the head casting.

Also four valve seats of the insert type are in place in the valve ports. In addition to this, the head joint to cylinder block was not designed to use a gasket on this type engine, but the head has a raised ring seat which is a lapped fit to the top of the cylinder liners in the block.

Various methods of working on these heads are in general use, the most common one being the simple but cumbersome method of placing the head on a truck after lifting it off the top of the engine, and trucking it to a cleaning tank. After cleaning, it is placed on a bench or table and inspected for surface defects, using a dye process or magnetic particle testing process.

As the head contains water spaces for cooling it is necessary to pressure test it for any defects in surfaces not

*Superintendent of Transportation and Traffic Services, Rouge Plant, Ford Motor Co

possible to detect by visual inspection. After the water pressure test and a satisfactory surface test, it is again placed on the bench (using crane or lift of some type) and valve guides checked for wear.

When valve guides are found worn beyond tolerance, the head has to be turned over and placed on an open-spaced horse or table and the guide driven out with block and sledge, or pressed out after being taken to the press location; or if available a portable pressure apparatus can be used, which would be brought from a tool crib and bolted to bench or table in position to press out guide or guides. This apparatus has to then be dismantled and the head turned over again and placed back on bench or table so that new guide or guides can be pressed in, which requires the apparatus to be re-assembled and used and then again dismantled.

Repetition

Before turning the head back over the injector hole has to be cleaned and the old seat gasket removed and new one applied. The head then has to be turned over again to work on valve seats. Valves are inserted one by one and lapped in. Then head-to-liner seat has to be lapped in, using lapping ring by hand.

After washing clean, valves are inserted, then the head turned back over upright on open horses so valve springs can be applied and so that the seat will not contact any bench or table and become damaged. Valve springs are applied on each of the four valves in turn and keepers applied in turn, which requires a valve compressor tool to be mounted and dismounted four times.

Complicating all this turning over are four long rocker box studs and two short injector nozzle studs, projecting up on top of head to 14" and 3" respectively, which are left in place for reasons of economy.

Finished head is oiled and set on storage rack and another head taken from cleaning vat and the above processes and work repeated.

Upon observation, possible improvements suggested themselves immediately from the removal of the heads on through. Why handle them from the engine to floor or cleaning vat singly? A mechanic is on top of the engine at the time and regardless of type of lift used, whether overhead crane, or hoist, the heads could be set immediately in some frame or jig. A pair, or three or even all six heads could be conveyed from engine to cleaning vat or floor bench at one lift, or a maximum of three lifts if two heads were paired off together. After cleaning, this assembly of carrier frame and two heads would be placed on the head-working jig or fixture.

We designed the device shown in Fig. 1. A simple fastening is made to this jig by means of a long pin inserted at this time thru the frame holding the cylinder heads and the frame of the jig at waist height above the floor. Frame and heads are now in balance and are secure for work on the valve fastenings. The valve springs, stems, and long rocker box studs are pointing upward. A thin steel plate is placed on underside of one head, which is of correct diameter to cover the four valves. A long bolt is passed thru a hole in the center of this plate upward thru the injector hole of the cylinder head. This is then secured with a wing nut.

Smooth Operation

The valve-spring pressure plate (kept on a hook on back of main jig frame when not in use) is now placed on the four valve stems and keepers. A swinging-type arm mounted on one of the vertical posts of the jig is swung over this plate and a small hydraulic jack is placed in position under the arm in position to force the plate downward, compressing the four valve springs simultaneously, exposing the four valve keepers for removal. The keepers are removed, the jack released and the springs come up free.

Plate and springs are removed and the retaining plate secured through the injector hole prevents valves from falling to the floor. This retaining plate is left in place until same process of removing keepers and valve springs has been performed on the other head. Now, we have the two heads with valves free and ready to come out.

As the next step in sequence will be a water pressure test with valve seats of heads exposed, we pull out the lock support pin of the frame and because the frame and heads are suspended on a line at their center of gravity, (horizontal) the assembly can now be easily turned over (in vertical plane parallel with body of operator facing jig).

Water Pressure Test

When turned over the locking pin is again inserted into jig under frame holding heads and heads are now upside down and no physical exertion or hoist equipment has been required. The valves of both heads can now be lifted out after removing holding plates. The water passage inlets and outlets of heads are now blocked off and connection to plant water pressure line made. During time pressure is turned on, on both heads, close inspection can be made of all surfaces of the underside and sides of heads.

By removing locking pin the heads can be rotated to right-side up position and top surfaces inspected. If found satisfactory, water is shut off, lines disconnected and removed.

All valve guides are next inspected for wear and tolerances. These are checked in sequence with mandrels for wear and size. If found OK they are not disturbed, but those found beyond limits of wear are marked for removal. Assembly is then rotated with guides on the bottom (heads upside down) and removal of defective valve guides in each head is

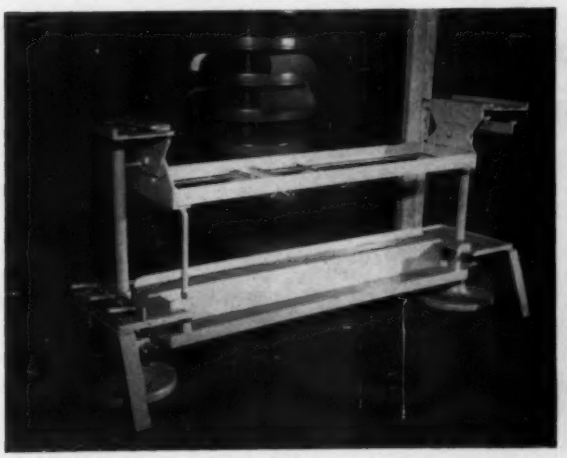


Fig. 3. Fixture for holding cylinder head castings of three or more cylinders for upright or inverted maintenance work

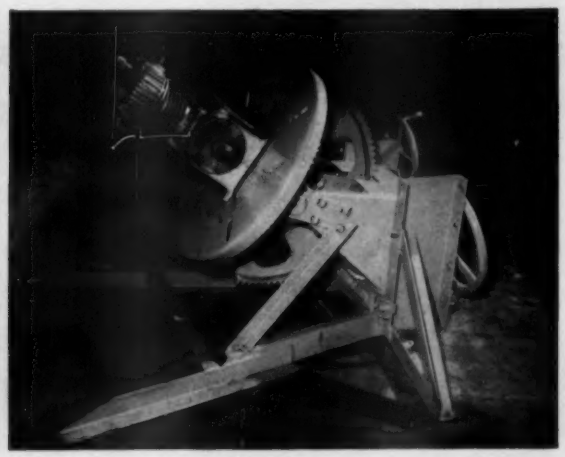


Fig. 4. Turnover fixture for the dismantling and assembling of equipment, and holding parts in any position for welding

done using the same small hydraulic jack used to compress valve springs.

As guides are necessary for the correct checking of valve seats prior to finishing new valve fit (lapping or grinding) to the seats, heads are now turned back over and locked upright and new guides pressed in with same jack.

Work of valve seat refinishing with stones or lapping new valves, or reclaimed valves, to each seat is done with heads again turned over.

When all eight valves are finished, the head joint ring on each head is then lapped in, using lapping ring of cast iron of same size and fit found in cylinder liner.

Reassembly

After both joint seats are lapped to perfect condition for service use, the heads are thoroughly cleaned, and each set of valves inserted, the retaining plates and bolts are again applied. The heads are now turned right side up and using a spring compressor plate on each head after springs are set in place, the caps and keepers are applied, and the two heads are ready for storage or return to the engine.

If they are to go to storage, a wooden circular plate three quarters of an inch thick of sufficient diameter to extend over the joint seat, is applied to hold valves in place for the application of springs and keepers instead of the same steel plate used for dismantling them, as the joints must be protected while in storage and this wooden plate will still retain valves in guides while springs were being applied. If the heads are to go directly to the engine, the steel plate is removed before taking heads off jig (or taking frame of jig with two heads still mounted in it), and sending them to engine for application.

Preliminary time studies of methods and operation in repairs of these cylinder heads were made by the shop supervisor. After the improvements were analyzed and various solutions became obvious, the ideas were presented to the department superintendent. After screening and further check of benefits to be obtained, sketches were sent to the Design Engineer and final drawings made and approved for construction of the jig.

Designing the Jig or Fixture

The Design Engineer necessarily has a wide background in use and development of shop machines, tools, layout, paths of material and repair parts movements in the particular shop or building.

Selection of materials used in construction of the jig is confined to standard structural metal shapes and items readily obtainable without special machining. Guide pins, bushings, dowels and quick action fasteners are selected and used wherever advantageous. In many cases the weight of fixture is critical and light weight shapes, made of aluminum or alloys, will be used.

Forgings and castings are avoided to keep costs at lowest practical minimum. Flanges, holes, studs, etc, already in a sub-assembly or single part are used wherever possible for application of fastening and holding features in new jig to maintain simplicity and quick mounting and dismounting of part when set in to the jig or fixture.

For example, in the subject jig for large cylinder heads it would be possible to mount angle irons on each side of proper length with bolts through present cylinder head stud holes. The heads are of such size and stiffness that they would make a strong stiff assembly when angle iron fastening was made.

As cross members at ends of angle irons are required it was decided to make a complete rectangular frame for this jig, as the frames when empty are more easily handled than loose angle irons. The loose angles would also require locating bushings to index the heads in proper position in relation to rotating axis of the asembly when in the frame of the jig. Difficulty in handling these loose parts would be encountered when not in use.

Multiple Considerations

In selecting the materials for the jig the influence of any movement of the part mounted in it is of paramount importance. The assembly of the part in place on the fixture must be quickly and easily done, and any movement of the part to get to its sides, bottom, or any recessed surface or cavity is carefully analyzed. Any physical effort to move it must be kept at a minimum. One factor that determined this design to be suitable for two heads instead of three was the possibility of balancing in the jig so the "turn-over" could be done easily.

If three heads were mounted in the frame it would reduce time of getting them off engine on their way through the processing. However, considering their weight, it was impossible to balance three heads on the jig unless they were to be turned over on an axis parallel to the stance of the repairmen facing the jig. This would have prevented using posts to support horizontal arms for the jack when pushing valve guides in or out.

In the scrutiny of component parts and fastening of such assemblies or single parts, the designer attempts to furnish the jig or fixture with as many holding pegs, holes, slots and cups as possible in order that all the cap bolts, screws, nuts, etc, used in the fastening of the item to the main assembly can be placed on the jig and travel throughout the repair cycle.

In this manner a great saving is made in re-use of fasteners and when the item is finally assembled to the main part of the machine where it is used, the workman finds all the parts, including the fastener, on the jig, and discards only those not fit for re-use. This results in saving of trips to the stock room for these parts and also results in conservation of material.

Some peculiarly adaptable items for this system are carburetors, fuel pumps, regulators, and control devices, cylinder heads, piston and connecting rods, cylinder blocks, crank cases, hydraulic components, gear boxes, transmission assemblies, and any other sub-assemblies attached to engine, vehicle frames, on machines of all kinds.

Development of such fixtures minimizes physical effort, decreases physical assets required in the repair operation, increases efficiency of the repair operation, increases service periods of the part through more accurate inspection and repair methods, and pays off in reduction of overall costs. In this day and age every movement of parts and material should be subjected to the most intense analysis as there are possible economies present in most cases, only waiting for someone to "pick the ripe fruit."

THE END

Big Pay-Off for Overhead Training

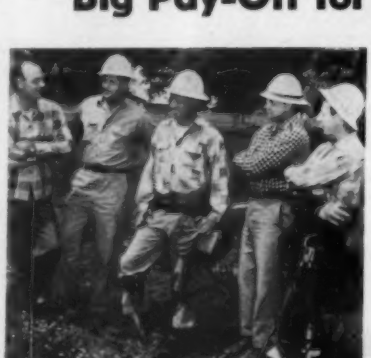


Fig. 1. Fred Beane, left, rejoins pals Simmons, Hagstatz, Runkle, Eggleston

RIGOROUS PRACTICE in pole-top resuscitation probably saved the life of a Commonwealth Edison lineman. Simmons saw Beane suddenly slump in his safety belt, unconscious from accidental contact with a live conductor while working on a pole.

Eggleston discarded his tools as he ran to the pole, climbed and began resuscitation. Hagstatz literally slid down another pole, and ran for the truck Runkle was already driving toward Beane's pole. With safety line and blanket, Beane, regaining consciousness, was lowered to the ground.

Simmons had already called doctor and ambulance. Runkle directed them from the nearest intersection. After two days hospitalization, Beane was released.

WATER PROBLEMS: SCALE DEPOSITS • EMBRITTLEMENT • FEEDLINE AND HEATER DEPOSITS • HIGH BLOWDOWN RATE • CARBONIZED OIL • STEAM AND CONDENSATE PROBLEMS: CARBON DIOXIDE GROOVING • OXYGEN PITTING • TURBINE BLADE DEPOSITS • SUPERHEATER FOULING • OIL CONTAMINATION • CONDENSER LEAKAGE • PROCESS CONTAMINATION • COOLING AND PROCESS WATER PROBLEMS: DEPOSITION OF SCALE • GENERAL CORROSION • PITTING AND TUBERCULATION • SLIME AND ALGAE DEPOSITS • FUNGUS ATTACK OF COOLING TOWER WOOD • PRODUCT CONTAMINATION • RED WATER • PRELIMINARY TREATMENT PROBLEMS (Removal of Impurities): TURBIDITY, MUD, SILT • EXCESSIVE COLOR • IRON AND MANGANESE • SOLUBLE SILICA • HIGH HARDNESS • ACIDITY OR ALKALINITY • OBJECTIONABLE GASES—CO_2, H_2S, NH_3 • MICRO-ORGANISMS • GENERAL PROBLEMS: POOR QUALITY WATER SUPPLY • WASTE OF WATER—LACK OF RE-USE • INADEQUATE PRETREATMENT EQUIPMENT • IMPROPER CONTROL OF EXISTING EQUIPMENT • UNSATISFACTORY CHEMICAL FEEDING • STREAM POLLUTION • WASTE DISPOSAL • HIGH COSTS • IMPROPER OVERALL WATER CONDITIONING PROGRAM • BOILER WATER PROBLEMS: SCALE DEPOSITS • EXCESSIVE SLUDGE • GENERAL CORROSION • PITTING • CARRYOVER • EMBRITTLEMENT • FEEDLINE AND HEATER DEPOSITS • HIGH BLOWDOWN RATE • CARBONIZED OIL • STEAM AND CONDENSATE PROBLEMS: CARBON DIOXIDE GROOVING • OXYGEN PITTING • TURBINE BLADE DEPOSITS • SUPERHEATER FOULING • OIL CONTAMINATION • CONDENSER LEAKAGE • PROCESS CONTAMINATION • COOLING AND PROCESS-WATER PROBLEMS: DEPOSITION OF SCALE • GENERAL CORROSION • PITTING AND TUBERCULATION • SLIME AND ALGAE DEPOSITS • FUNGUS ATTACK OF COOLING TOWER WOOD • PRODUCT CONTAMINATION • RED WATER • PRELIMINARY TREATMENT PROBLEMS (Removal of Impurities): TURBIDITY, MUD, SILT • EXCESSIVE COLOR • IRON AND MANGANESE • SOLUBLE SILICA • HIGH HARDNESS • ACIDITY OR ALKALINITY • OBJECTIONABLE GASES—CO_2, H_2S, NH_3 • HIGH SOLIDS

Power Engineering handbook

How to Maintain Centrifugal Pumps

6 — Bearings

By J. A. CABLE * and O. M. KRISTY, Jr *

IN EARLIER chapters we covered rotating element components — shafts, sleeves and impellers. In this chapter we will discuss the part that allows the rotation of these components — the bearings.

Most bearings used in pumps today fall into two divisions: 1. sliding contact or journal bearings; 2. rolling contact or anti-friction bearings.

Sliding contact or journal bearings are still frequently used in centrifugal pump design. The more common types are shown in Table I (page 102).

More frequently, however, rolling contact or anti-friction bearings are used in centrifugal pumps. Table II includes only the types most frequently encountered and does not include all of the types that are available.

If sliding contact or journal bearings are used, it is necessary to provide a thrust bearing of some type. Usually this is the outboard pump bearing.

The thrust bearing may be a Kingsbury type (Fig. 2) with a combined journal bearing and thrust; or a collar type (Fig. 1) which is a combined journal bearing and thrust collar. Principal difference between the two is that the Kingsbury type of thrust bearing has pivoted thrust shoes that are renewable, while the collar thrust bearing has a continuous, solid, annular bearing face, and is renewable only by replacing the entire bearing shell.

For heavy loads and high speeds, a full self-aligning Kingsbury type of bearing is used (Fig. 3). This design not only features replaceable thrust shoes, but also thrust shoes that are full pivoted and self aligning.

It is also common practice on many pumps to use an anti-friction bearing such as mentioned in Table II as the outboard bearing to provide both thrust and radial load capability. The inboard bearing could be a journal type of bearing, as mentioned in Table I.

Unless the pump is fitted with anti-friction bearings at both ends of the shaft, the outboard or thrust bearing will be either an anti-friction bearing capable of both thrust and radial load, with an inboard journal bearing, or the unit will have journal-bearings at both ends for radial load, plus a full Kingsbury or Kingsbury type for thrust load only at the outboard bearing location.

After the type of bearing has been chosen, proper lubrication should be considered. Basically a bearing is lubricated to: 1. reduce friction; 2. remove heat; 3. prevent corrosion of the bearing parts.

Therefore, with these factors in mind, plus consideration of local ambient temperature, dust and dirt, and possible moisture (such as direct rain or condensation), the proper lubricant can be chosen.

Because each installation should be considered on its own merits (based on the requirements listed above), the following recommendations are to be taken as typical only:

For oil-lubricated bearings use a good grade of filtered mineral oil (SAE 10) or approximately 150–250 S.S.U. at 100 F. Oil should be changed whenever it becomes dirty or contaminated, and the bearings and bearing body thoroughly cleaned before replenishing the supply.

Oil-lubricated bearing will require daily attention to be certain that the oil cups, drip feeder, reservoir, etc, are filled to the full mark. Do not overfill, for this usually results in over-heating of bearings.

Grease-lubricated bearings should be

* Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

fold along this line—outside edges toward you

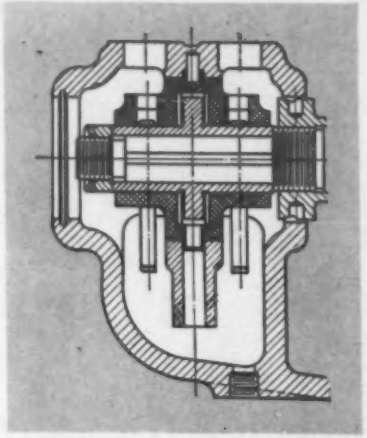


Fig. 1. Sleeve bearing assembly which combines a journal bearing with thrust collar. See Fig. 2

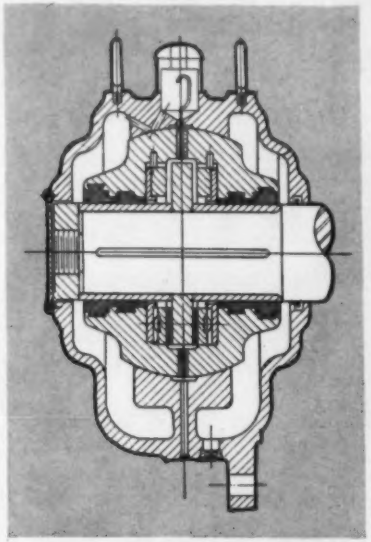


Fig. 2. The Kingsbury type of thrust bearing has a combined journal bearing and a thrust collar

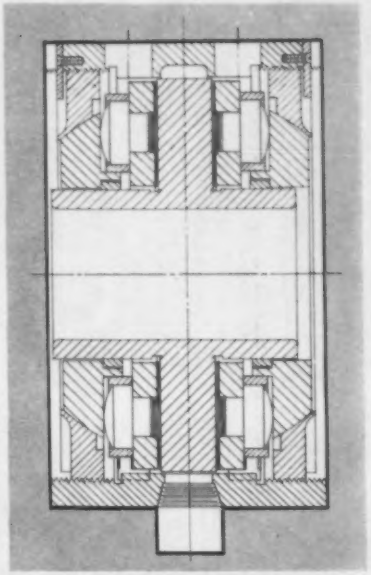


Fig. 3. For heavy loads and high speeds, a full self-aligning Kingsbury type of bearing is used

POWER ENGINEERING HANDBOOK

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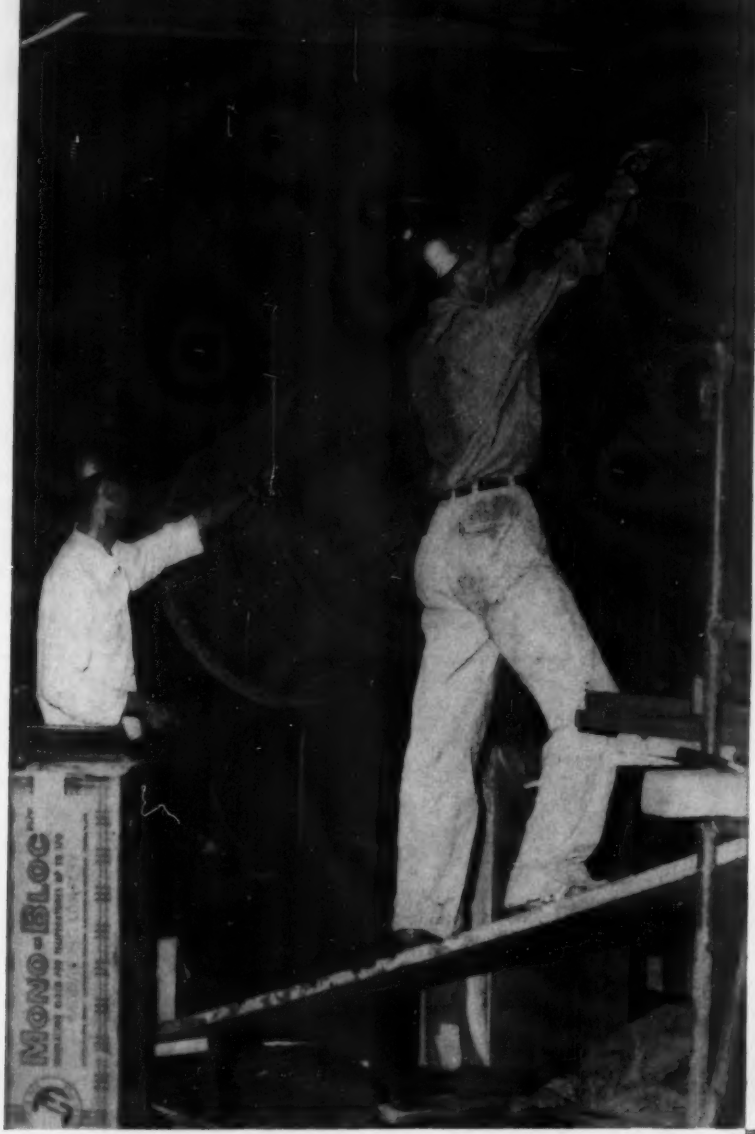

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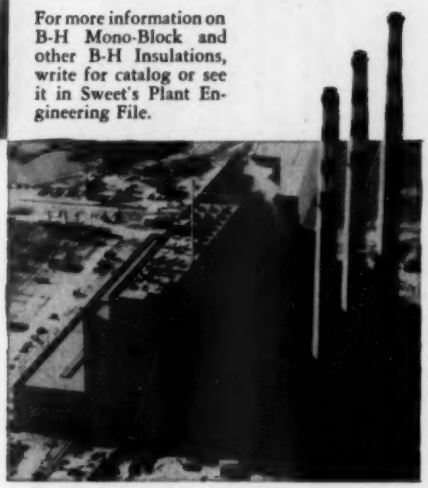

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Table I. Shown here are the more common types of sliding contact or journal bearings used in pumps

TYPE	MATERIAL	LIMITS	COMMENTS
Bushing	Bronze	Shaft speeds to 900 fpm. Loads to 3000 psi	Simple construction, low first cost.
Bushing	Oil-less Bronze	Shaft speeds to 1500 fpm. Load top at 100 psi	Low cost, simple, self-lubricating, quiet.
Bushing	Babbitt lined (thin linear-iron, steel or bronze backing)	Shaft speeds to 4000 fpm. Loads to 5000 psi	Heavy duty, general purpose, long life. Good for dynamic loads.
Bushing	Molded plastics (also laminated)	Shaft speeds 400 fpm. Low loads, max. 2500 psi	Low friction, water-lubricated, must be well cooled.
Bushing	Rubber (bronze, steel or stainless steel backing)	80-psi loads. 4300 fpm shaft speeds	Low friction, water-lubricated, withstands abrasion, shock absorbent, long life.
Bushing	Carbon-Graphite	Under 850 F, 600 psi. At low speeds to 20,000 rpm at low psi	Light duty, no lubrication required.

Table II. Here are the rolling contact or anti-friction bearings most frequently used in centrifugal pumps

	TYPE	CHARACTERISTICS
A	Single-row deep-groove ball bearing	Good radial load and reasonable amount of thrust in either direction. Requires good alignment. High speed.
B	Angular-contact ball-bearing	Heavy thrust one direction. Moderate radial load. With sides flush ground, can be used in multiple numbers.
C	Spherical roller bearing	High load capacity, both radial and thrust. Thrust either direction. Self-aligning.
D	Single-row tapered roller bearing	Good for heavy one-way thrust or combined load. Predominantly thrust load. Requires adjustment of internal clearance.

supplied with a high-grade grease with a soda soap base compounded with refined, clean mineral oil. This should be free from corrosive matter, grit, rosin, talc, mica, clay, or fillers of any kind, and conform to the following specifications:

Consistency (Karres-Maag method) — ash maximum, 2 per cent; 20 mm to 35 mm at 750 F; moisture maximum, 2 per cent.

Corrosion — bright copper plate should show no discoloration when submerged in the grease for 24 hours at normal room temperature.

Mineral oil from which the grease is compounded should conform to the following tests:

Flash—minimum	340 F
Fire	380 F
Viscosity at 100 F S.S.U.	200 sec. min.
Cold Test (Powt) Maximum	Plus 30 F

Grease-lubricated bearing will require attention only about every three to six months. Over-greasing of the bearing either in terms of too much grease or under too great a pressure will pack the balls and prevent them from rolling in the races. This causes sliding contact in the races, which results in galling and early bearing failure. As part of the maintenance program, bearing temperature, noise and cleanliness should be checked daily.

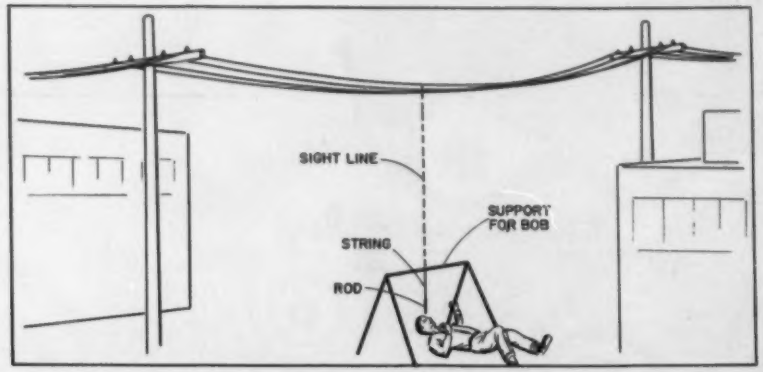
It is advisable that a lubrication time table be established for each pump, based on its usage, ambient temperature, and operating conditions. Shortly after start-up, the bearing should be drained, cleaned, inspected, and relubricated with the proper grade and amount of lubricant. (See your local lubrication engineer for help on this choice.)

Noting the condition of the bearing and lubricant, the running time can either be lengthened or shortened before the next inspection and relubrication cycle. Thus by drawing on your particular operating experience and data, you can set the proper maintenance schedule.

fold along this line—outside edges toward you

Upside Down Plumb Bob Solves Tricky Sighting Problem

By MICHAEL LICHSTEIN*



Clear line of sight was broken by buildings, so plumb bob was reversed, observer lying on his back

DURING the construction of a plant it became necessary to find the horizontal clearance between an existing 13,000-v aerial line and a steel column that was to be erected on a concrete footing. Problem was to find the projection on the ground of the location of the aerial line with some reasonable accuracy and without touching the hot line.

Surveying instruments were available but a clear line of sight was not, since the line dipped over a number of buildings.

If the line were dead the simplest method would have been to hang a plumb bob from the line, but with a hot line this couldn't be done.

The idea suggested itself — why not use the plumb bob in reverse? By hanging a thin rod such as a welding rod from a string, with the observer lying flat on his back and sighting on the line from below, back up along the string, the location of the line was charted on the ground accurately enough to measure the clearances.

*Electrical Engineer, United Engineers & Constructors, Inc

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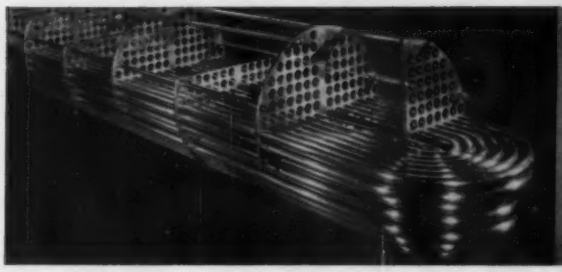


CONDENSER AND HEAT EXCHANGER CLINIC

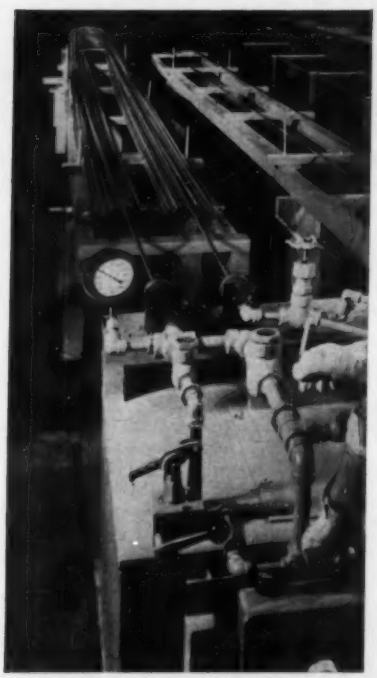
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New controls and services meet increasingly critical requirements in heat-transfer units

As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100′—can be inspected electronically by eddy-current equipment.



All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.

All tubes are inspected visually one at a time, both externally and internally.

When required, tubes are inspected by eddy-current equipment, located at the tube straightener.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASME Code pressures. They can, however, be tested at higher pressures, up to 6000 psi, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

TUBES AND PLATES FOR CONDENSERS and HEAT EXCHANGERS

Made by

THE AMERICAN BRASS COMPANY

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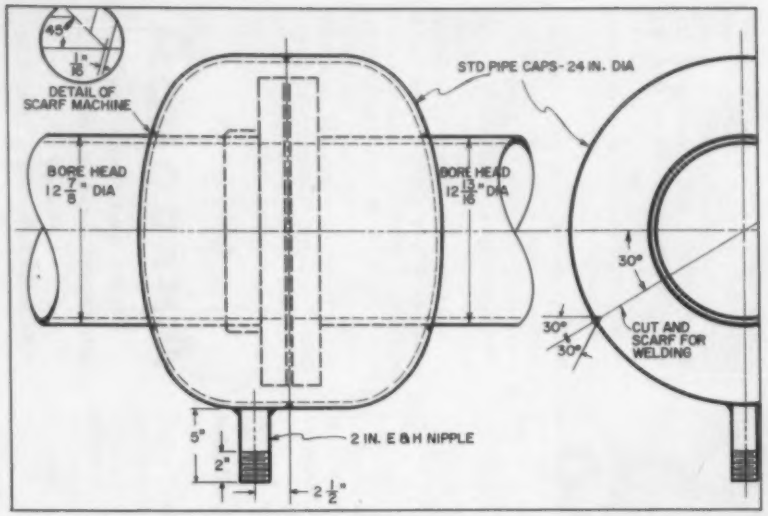


Method of repairing steam leak, 110-lb header, encloses leak in a welded steel jacket of pipe caps

Unique Method of Stopping Leak in Steam Line Under Pressure

By WILLIAM C. DURNING*

MANY steam mains develop leaks which cannot be neglected; however, it isn't always possible to take the line out of service long enough for repairs. This is particularly true in process industries.

One method we've found very effective is the relatively simple expedient of enclosing the leak in a welded steel jacket. As an example, a sizable leak was found in a 12-in. steel pipe flanged joint. The leak was stopped by this method:

1. Two standard 24-in. pipe caps were used for the "enclosure."
2. Holes were cut in each of these caps, the size of the steel pipe which was leaking.
3. The pipe caps were then cut in half and scarfed for welding (see figure).
4. In one pipe cap, a 2-in. extra-heavy pipe nipple was welded. (This was a temporary steam leak escape.)
5. The split pipe caps were placed around the steam main, and welded back into whole caps.
6. Caps were pushed together and welded around their circumference.
7. Caps were then welded to the steam main, as shown in the figure.
8. Final step was to place a cap or valve on the pipe nipple.

This repair method has successfully saved several shut-downs in our process lines. In some processes, even an emergency shut-down of short duration can cost thousands of dollars in product waste. So, even if this type of repair is expensive, in itself, it can result in a great overall saving.

* Superintendent of Utilities, Monsanto Chemical Co

fold along this line—outside edges toward you

How to Prepare and Maintain Handhole Fittings and Openings

SEAT LANDING of a handhole opening must be perfectly clean, true, and free of defects to obtain a satisfactory gasketed seal. So it's obvious that to assure absolute tightness, any pits, indentations or scars would need to be removed by accurate surface grinding or refacing.

Generally such reconditioning is not necessary. However, a cleaning to remove all surface deposits is necessary, to make sure that all mating surfaces are perfectly clean. The following procedure is outlined in the *Bureau of Ships Journal*.

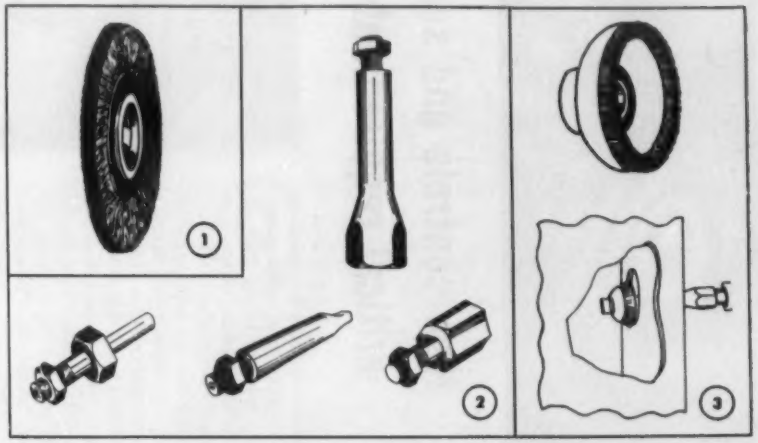
A tight joint cannot be obtained if surface deposits are not removed, not only from the seat landing surfaces but also from the corners of the handhole and fitting. Power-driven wire brush wheels can be used to good advantage in cleaning up seats which have surface deposits. Only cup and circular wire brushes should be used for external cleaning; don't use scraper-type tools.

Circular wire brush (Fig. 1) can be used to clean the handhole plate effectively, and the cup wire brush (Fig. 3) does an excellent cleaning job in the handhole opening. It is used as shown in the figure. Any power tools, either electrical or air driven, can be used, with mountings for holding the wire brushes as shown in Fig. 2.

It has been demonstrated at the Naval Boiler and Turbine Laboratory that air motors with the tube cleaning kits for brushing the watersides of boilers can be effectively used if there are no other power tools. Air motor sizes C-8, C-10 and C-12 have been used, the *Journal* reports, the latter two being very satisfactory.

A circular wire brush (crimped wire, class 1, 3-in. diam, 0.015-in. wire size, ⅜-in. diam arbor hole, and approximately 5/16-in. wide through hub) has proved very satisfactory for cleaning the handhole fittings seating surfaces.

The cup wire brush has a 2-in. face diam, ⅜-in. or ¾-in. arbor hole, with a 3/16-in. wire projection. It can be obtained from Thomas C. Wilson, Inc, Long Island City, N. Y.



Figs. 1–3 show brushes and mountings described in text. If cup brushes with a longer wire projection and about 2-in. diam are available locally, trim excess to 3/16-in. to furnish the stiffness necessary for cleaning

cut along this line

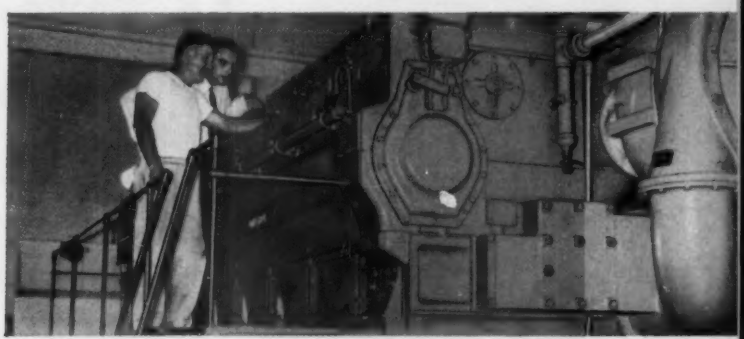
SLUDGE *situation gets a clean-up*

STANODIESEL Oil M helps keep diesels clean and running smoothly at Princeton, Missouri

The situation: Consumer Public Service Company, Princeton, Missouri, has three diesels in service—a 225 hp unit installed in 1951, a 1,083 hp unit installed in 1954 and a 1,440 hp unit installed in 1956. In previous equipment, sludging had been a problem, so when these units went into service, a heavy duty oil was recommended—STANODIESEL Oil M.

What has happened: The oil has been inspected regularly by a Standard Oil lubrication specialist. Samples are periodically removed for analysis at Standard's Whiting Indiana research laboratory. Analysis shows the oil to be in excellent condition. Since the 1,440 hp unit was started up in 1956, it has generated 1,672,200 kw hours of electricity.

What you can do: Find out more about how STANODIESEL Oil M can deliver service in your plant. Ask for more information from the Standard Oil lubrication specialist near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Darrel McCormick, Standard Oil lubrication specialist and William Rutledge, plant superintendent, inspect 1,440 hp diesel in Princeton, Missouri plant. Darrel is an experienced hand at this work. He has an engineering degree from Vanderbilt University plus four years' experience in industrial lubrication work at Standard Oil. He has also completed the Standard Oil Sales Engineering School.

Quick facts about STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

You expect more from STANDARD *and you get it!*

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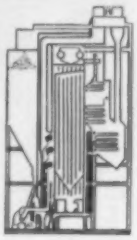
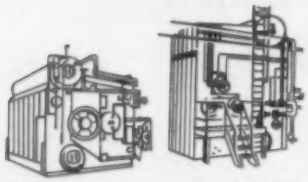
Power Plant Products

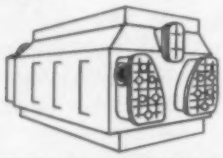
HEAT ENGINEERED BY FW

LARGE STEAM GENERATORS
Designed to meet all requirements for Central Station or industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.



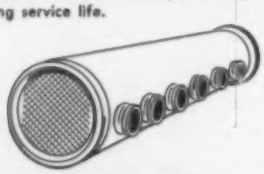


PACKAGED and FIELD-ERECTED BOILERS—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr, oil, gas or pulverized coal fired.

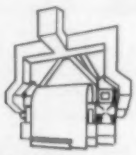


CONDENSERS and HEATERS—Condensers of single or two-pass, double or counter-flow designs. All-welded high and low pressure feed-water heaters.

COOLING TOWERS—Induced draft counter flow towers of all-redwood construction for maximum dependability and long service life.



NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.



PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

HEAT ENGINEERING

WORLD'S FIRST

NATURAL CIRCULATION

321,500 kw Unit No. 3 at Detroit Edison's River Rouge Power Plant is served by a Foster Wheeler Reheat Steam Generator —one of the most efficient ever built

One of the largest steam generators ever built, this unit was heat engineered by Foster Wheeler to meet the most exacting plant requirements. It supplies Detroit Edison's River Rouge Unit #3 with *two million* pounds of steam per hour at 2450 psi and 1050 F at the superheater outlet. The steam is reheated to 1000 F after it has passed through the initial stages of the turbine.

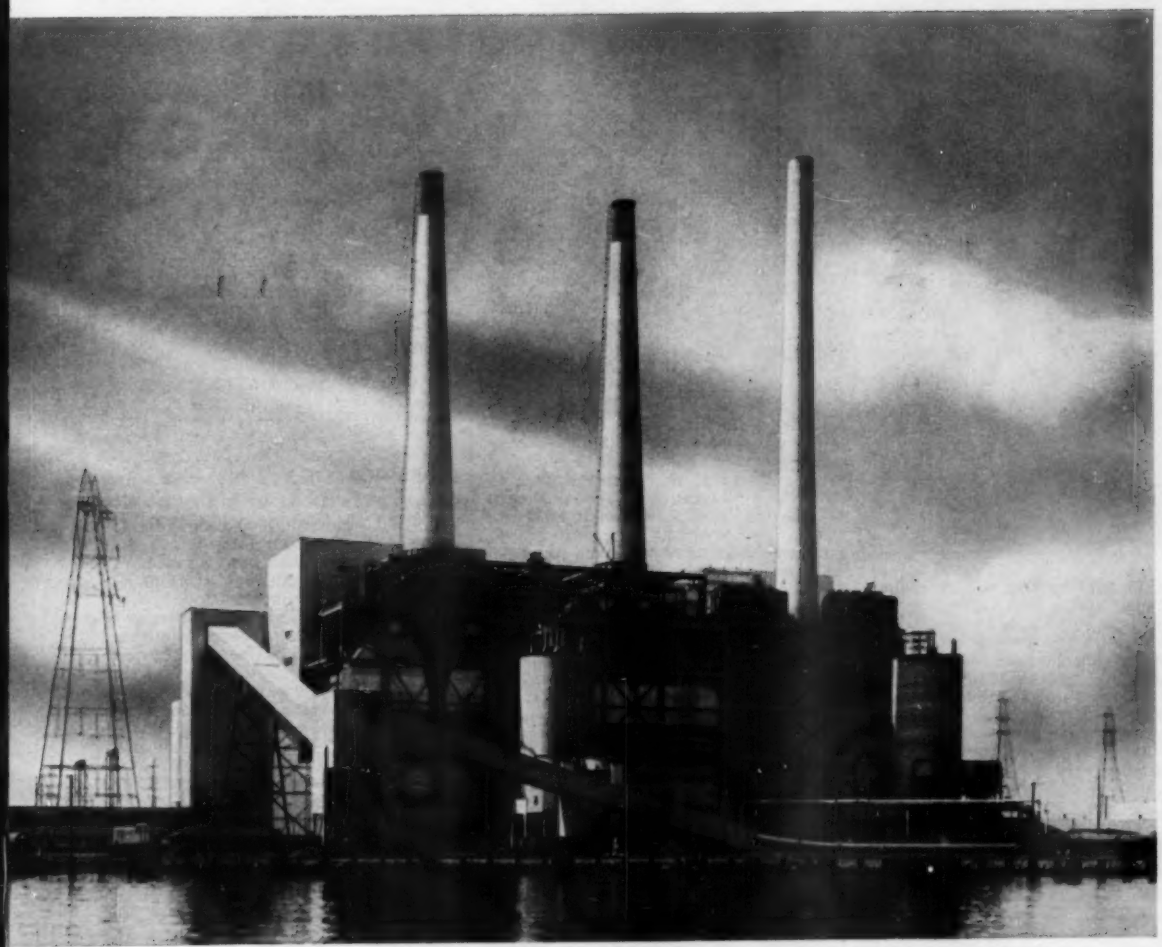
Size alone is not the only measure of this installation. The FW steam generator also helps make Unit #3, with a heat rate of 8685 Btu per kwhr, one of the most economical and efficient ever built, producing a kilowatt hour of electricity from less than ¾ lb of coal.

With more than a half century of specialized experience in heat engineering and steam generation, Foster Wheeler will welcome the opportunity to quote on your steam plant units—for any pressure or any capacity. Foster Wheeler Corporation, 666 Fifth Ave., New York 19, N.Y.

by Foster Wheeler creates

2,000,000 lb/hr

STEAM GENERATOR



FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 119–120 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—CONTROL lets compressors work closer to surge point

For large compressors, blowers and exhausters, the packaged CompuDyne Surge Control System is designed to improve operating stability, reduce power consumption and increase safe output of such equipment. With this system, compressors can be safely, operated nearer the surge point than formerly possible, company states. The system can be used on units from 50 hp up. It consists of electronic sensing, measurements and control instruments, plus an electric-hydraulic or electro-pneumatic actuator and control valve as final control elements. Data Bulletin 4007 gives further information. CDC Control Services, Inc.

2—PRESSURE REGULATOR PILOT is super sensitive device

Fig. 8000 pilot is designed to reduce and regulate pressure of steam, air gases and liquids within fractions of a pound in one stage. It uses air or water pressure (20 to 75 psi) to actuate the control valve, can be used with single and double seat valves ¼ to 12 in., and can be modified for reverse action. Applications include maintenance of constant reduced

pressure in heating and service mains, vats, press platens. The valve can also maintain a constant level in open tanks or as a pump governor where a constant delivery pressure is required. Manufacturer says that the weight-loaded diaphragm pilot responds to minute changes in controlled pressures to govern the diaphragm or piston control valve. Use of outside water or air pressure provides the regulator with power to close the main control valve. Atlas Valve Co.

3—METERING PUMPS offer neat appearance, efficiency

Streamlined appearance, provided by a handsome safety shield, is stressed for the Masterline Metering Pumps, but other features announced include economy, improved accuracy, parts interchangeability, operational efficiency and maintenance ease as well as a new crank-type design. The pumps are available in four models, single- and two-feed, in capacities from 0.92 to 1030 gph. The pumps are powered by standard NEMA foot-mounted motors, and speed reducers are separate from motors to simplify replacement. An improved drive mechanism is also announced as well as simple stroke adjustment. Manual and

automatic "in motion" stroke adjustment is available as optional equipment. These pumps are covered in detail in Bulletin 900. Hills-McCanna Co.

4—DRY ACID CLEANER for industrial equipment

Based on sulfamic acid, Super-Sulfamic is announced as a dry acid cleaner ideal for removing scale and deposits from such equipment as steam boilers, heat exchangers, air conditioning and ice-making machines, and other vessels. No fumes result whether used dry or dissolved in water, company says, and it is not as corrosive as many other types of cleaners. Lee, Revere and Van Buren Chemical Co.

5—ACETYLENE DETECTOR tells if fault has occurred

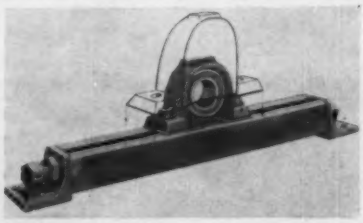
This acetylene gas detector is designed to detect acetylene gas in any power transformer having a sealed air space above the oil level. The detector is an elementary form of gas analyzer which detects acetylene gas in the air space of a solution of ammonia. Formation of a brick red precipitate in solution indicates presence of acetylene. This simple analyzing equipment is said to sense faults lasting for as little as three cycles. Westinghouse Electric Corp.

6—SKIN PACKAGING protects drawings, designs

Inexpensive and permanent protection of engineering drawings and other papers is announced for this skin packaging process involving a plastic film and a simple machine, the Skin-Pak, which consists of a vacuum system and equithermo heater. It takes about 10 sec to seal an item with the film, according to company, and more than one item can be handled at a time. The film is P. O. M. V. (Poly-On-Mylar Vacuumized), and because of its clarity, original drawings can be sealed before released for blueprints or photostats. It resists grease and is impervious to moisture, dirt and climatic conditions, manufacturer states, and has a life span of over 10 yr. Grease pencil or crayon markings can be made on the film. P. O. M. V. is low in price — it costs around 1¼ cents to seal an 8-by-11 in. drawing. Print-A-Tube Co.

7—TAKE-UP FRAME permits use of any pillow block

Either top or side-mounted, one basic frame size of the Versa Mount accommodates all types of pillow blocks — ball, roller or babbitted. Mounting is ac-



complished simply by loosening a locknut, which permits swinging flange connection either way. A large nut is mounted on both ends of adjusting screw, each ending with a heavy steel rod pin. This permits disassembly and removal of all parts without special tools. Adjusting screw is enclosed for protection against dirt, contamination, etc., but a face plate is removable for lubrication and cleaning. Sizes and travel lenghts range from 2 to 36 in., accommodating any pillow block from ½ to 2⅛ in. Lovejoy Flexible Coupling Co.

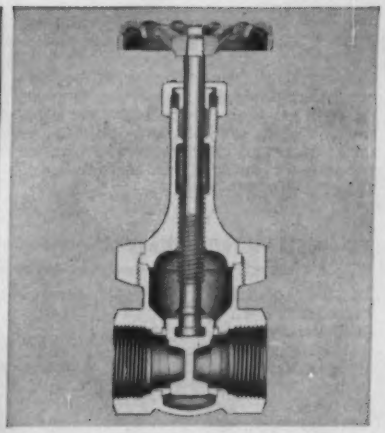
8—INDICATOR for fast checking of temperatures at many points

The 9000 Series Multi-Switch Indicator is available with switching details that let the instrument be used for as many as 108 stations. Additional stations can be added by using an additional switch housing cabinet. The basic instrument is a self-contained, null-balance unit and requires only external sensing devices. Selector switches are three-position spring return type with double-pole, double-throw action. The indicator uses an 11-in. scale, single or dual range. Balance speeds are 2, 4, or 15 sec. Reference junction compensation is automatic. Standard reference system is a constant voltage source with standard cell and battery optional. With proper circuitry and use of transducers, other variables and other quantities may be indicated. Wheelco Instruments Div., Barber-Colman Co.

9—GAS TURBINE ENGINE is compact, light in weight

THE GMT-305 Whirlfire is an automotive-type gas turbine engine developing 225 hp. Less than one-third the size of a diesel engine of comparable horsepower, the Whirlfire weighs only 650 lb, is 30 in. wide, 25 in. high and 37 in. long. Incorporated in it is a gas-coupled power turbine that functions as a built-in torque converter to assure full-rated power over a broad speed range. The Whirlfire is an air-cooled engine. Resid-

Expanded-type body rings. Made from Crane Exelloy—a 12% chromium stainless steel. Provide a hard surface that resists abrasive damage, indentation and scoring by foreign matter. Rings are rolled in, can't work loose. Seating wear is taken by easy-to-replace bronze disc.



Quality in every detail inside and out. In rising and non-rising stem patterns—¼ to 3 inches—screwed ends. Working pressures: 200 lb. steam, 550° F.; 400 lb. non-shock cold water, oil, gas and air, 150° F.

Cylindrical body shape. Proved on high-pressure steel valves. Increases body strength without adding bulk. Distributes pressure uniformly. Reinforces seating area against distortion and chance for leaks.

12% chromium stainless steel seat rings make Crane 200-pound bronze gates last longer

Here is a close-up of Crane quality that shows you why these 200-pound bronze gate valves perform more dependably than ordinary bronze valves, with less maintenance.

For example, instead of integrally cast seats, they have long-wearing 12% chromium stainless steel body rings. Rings are rolled in... can't work loose in service. This also prevents leakage around rings. The quickly replaceable bronze disc takes normal seating wear.

Crane 200-pound bronze valves are competitively priced with bronze valves which do not have these and other important features. Why pay for less than Crane offers you? For complete facts, see your Crane Representative.

Write for Circular AD-2285. Gives complete technical data on both rising and non-rising stem patterns.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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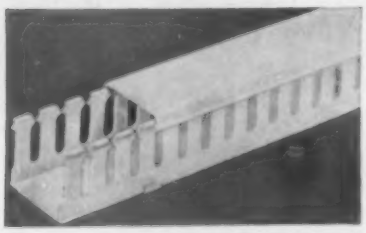
ual heat is rejected to the exhaust, where temperatures range between 300 and 500 F. Rotating regenerators are claimed 90 per cent effective in recovering exhaust heat and in quieting exhaust noise. The Whirlfire operates on kerosene, leaded or unleaded gasoline, or diesel fuels and can be adapted to burn propane or natural gas. Allison Div., General Motors Corp.

10—BTU METER utilizes single recorder to show loss, gain

In the Model 913 Btu Meter, a single recorder is used to continuously record, indicate and integrate Btu loss or gain of a flowing liquid. Also on the same chart, temperature differential and flow rate of liquid are recorded. Primary use for the new Btu Meter is measurement of heat transfer in hot water generators, cooling towers, refrigerating systems and other heat exchangers. The Hays Corp.

11—WIRING DUCT matches white interior of panels

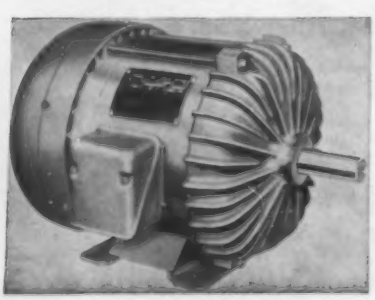
Panduct is an all-white wiring duct designed to match the white interiors of control panels and provide an improved appearance for the entire panel. Its high light reflectance allows greater internal visibility, company says, making wire installation and tracing easier. White



Panduct is made of polyvinyl chloride plastic. It comes in standard sizes ranging from ½ by ½ in. to 3 by 4 in., in the open-slot design as well as closed-slot and wire-hole designs. Panduit Corp.

12—SINGLE-PHASE MOTORS in TEFC, explosion-proof frames

These single phase motors in totally-enclosed fan-cooled and explosion-proof frames are available in two-, four- and six-pole speeds, in re-rated NEMA frames 182, 184, 213 and 215. Ratings range from ¾ to 5 hp. Condensers and centrifugal mechanism are enclosed within front end head, providing not only added protection for these parts, company points out, but also cleaner over-all appearance. Motors are designed for installation in any environment —



in deep areas, dusty or corrosive atmospheres and out-of-doors. Metal parts are protected with rust and corrosion resisting coatings. Motors are equipped with pre-lubricated ball-bearings which retain lubricant and at the same time seal out dirt. Robbins & Myers, Inc.

13—GATE VALVES can be serviced, tested in the line

These bonnetless gate valves, up to 2 in., are designed for complete and fast servicing and testing in the line. They

feature a one-piece forged steel body and bottom guide cover designed to permit removal and replacement of wedge, stem, back seat and two screwed-in seats in a matter of minutes. More positive closing and longer life are claimed. Testing for seat tightness is by closing the valve and removing a drain plug in the bottom cover, either under full pressure or during shutdown periods by applying air pressure from a test rig. Flushing of the valve and rapid decarbonizing are accomplished by removal of bottom guide cover. The valves are available with any trim and for 600 and 1500 psi service, as well as with bodies in carbon, alloy or stainless steel. Detailed information is in Catalog 300. Velan Valve Corp.

14—CABLE holds up to 56 pairs of thermocouple conductors

Thermo-Cable, a polyvinyl insulated multi-conductor cable for 6 to 56 pairs of thermocouple conductors, is announced as easier to handle and less expensive to install than individual pairs of thermocouple extension wire. Because its outer PVC jacket resists moisture, abrasion, heat and chemical action, Thermo-Cable can be installed in conduit, without conduit, in open troughs or in raceways. It is reported most advantageous where thermocouple extensions must be run a long distance from a number of thermocouples to measuring instruments.

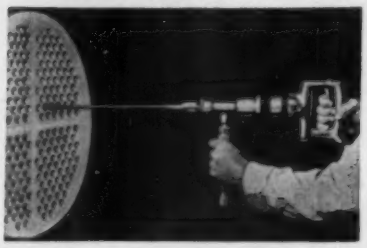
In this cable, individual conductors are insulated in polyvinyl chloride and then concentrically cabled with overall polyvinyl chloride insulation. Aluminum-backed Mylar tape, wrapped around the conductor bundle, provides electrostatic shielding. Thermo-Cable is made from 20 or 16 solid wire, or in 17-gage stranded construction when extra flexibility is required. Each conductor is ISA color-coded. All cables contain a copper wire which serves as either a ground or communications wire. Thermo Electric Co., Inc.

15—CONTROL VALVES offer large flow capacities

These split-body control valves for use in high-temperature, high-pressure control applications feature large flow capacities and face-to-face dimensions based on I.S.A. standards. Complete interchangeability of split-body line not only with regular globe-body diaphragm valves but with all other standard makes of diaphragm valves is made possible. Interchangeability is also a feature within the line. All major components — topworks, valve bodies, line flanges, plug and seat rings — are of unitized construction, making it possible to develop 432 different valve combinations from a single split-body. Details are in Bulletin 132. Kieley & Mueller, Inc.

16—CONDENSER CLEANER uses geared air-driven motor

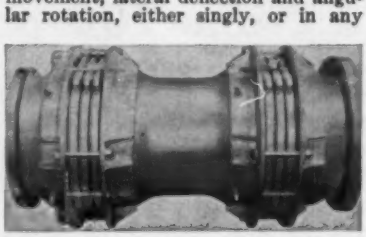
Redesigned for quick and thorough cleaning of severely clogged tubes up to 1-in. diam, the one-man operated CC-475 Condenser Cleaner weighs only 10 lb and can be used without supporting rigging. The improved cleaner is oper-



ated with a single-stage geared air-driven motor which operates at 3800 rpm, its speed controlled by a feathering valve at the handle. The motor is designed to run quietly and has a built-in flushing system controlled by a stainless steel sleeve valve to cool drill head, remove cuttings. The Airetool Mfg. Co.

17—EXPANSION JOINTS absorb all-direction pipe movement

According to manufacturer, these packless, corrugated bellows units protect piping systems by absorbing axial movement, lateral deflection and angular rotation, either singly, or in any



combination. They are also reported to absorb unlimited amounts of lateral deflection without imposing pressure thrust on piping or equipment, making heavy structural anchors unnecessary. Basic elements of the universal expansion joints include two hydraulically-formed bellows, a center section of pipe and appropriate tie rods. They come in standard sizes from 3 to 72 in. diam and, depending on pressures and temperatures encountered, are supplied with one of three types of bellows: non-equalizing, self-equalizing or hyPTor toroidal. The units can be designed to

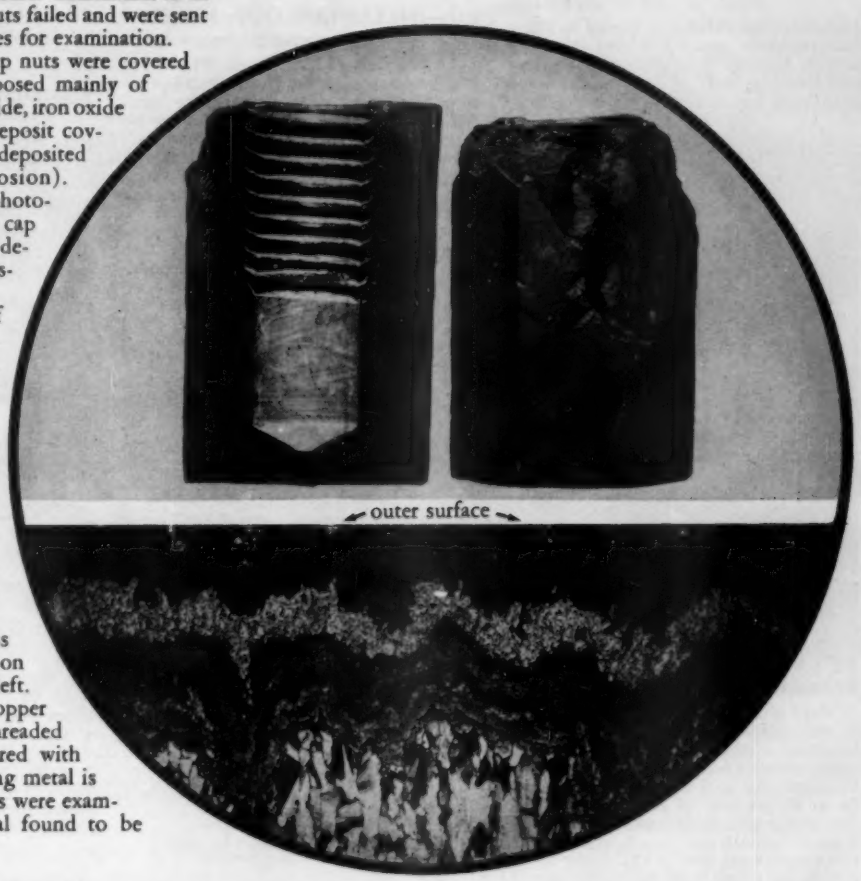
How to prevent CAP NUT failures like this

In a mid-western utilities power station, free-cutting brass cap nuts were used to hold the baffle in the head of a high pressure feed water heater. Unit operates at about 430°F and 1200 lb. pressure. Condensate is in contact with the nuts. These nuts failed and were sent to Revere Research Laboratories for examination.

The outer surfaces of the cap nuts were covered with a thin, black scale composed mainly of copper sulfide, copper oxychloride, iron oxide and copper oxide. The scale deposit covered a thick, uniform layer of redeposited copper (dezincification corrosion). Bottom photo at right shows photomicrograph of a section of the cap nut indicating the extensive dezincification corrosion progressing from the outer surface.

The soft, spongy layer of redeposited copper had penetrated to a depth of about ⅛". Examination disclosed that the initial corrosion is followed by a secondary reaction. Corrosion of a similar nature continues beneath the primary deposit of copper. In this way a brittle, porous copper gradually replaces the sound metal, eventually penetrating the cross-section of the metal, which results in a cracking of the nut.

Top photo of free-cutting brass cap nuts shows outer surface on the right and cross-section at left. Uniform layer of redeposited copper on outer surface is seen at left. Threaded portions of the nuts are covered with thin oxide film, while underlying metal is slightly corroded. Microsections were examined and the uncorroded metal found to be sound and of good quality.



Aluminum Silicon Bronze Logical Choice

Because susceptibility to dezincification corrosion increases with increasing zinc content of an alloy, the corrodent in the condensate responsible for the attack was probably dissolved carbon dioxide. Since neither free-cutting nor Naval brass nuts offer sufficient resistance to dezincification, aluminum silicon bronze would be the logical choice. When exposed to such severe conditions of service, this alloy combines good machinability with high corrosion resistance.*

Because no one alloy can possibly meet all the various conditions of use, Revere makes many different alloys for parts such as this as well as condenser and heat exchanger tubes and plates. Revere furnishes plates, in Cupro-Nickel, Copper, Herculoy, Muntz Metal, Naval Brass and Admiralty, and tubes in Cupro-Nickel, Aluminum Brass, Admiralty, Herculoy, Arsenical Copper, Muntz Metal and other alloys. Consult with Revere's Technical Advisory Service regarding the selection of the alloy best suited to your specific operating conditions.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Rome, N. Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

P.S. This Revere recommendation was accepted by the utility and there have been no cap nut failures since.

TO UNCOVER THE CAUSE FOR FAILURE IS TO PREVENT A RECURRENCE OF THAT FAILURE

For more data circle 552 on Post Card

handle medium pressures at high temperatures or medium temperatures at high pressures. Standard units are for pressure to 2500 psi and temperatures from – 320 to 1600 F. Special units are available for more severe conditions. Zallea Bros.

18—CONTROL VALVE handles flow in either direction

This two-way valve is designed to allow independently controlled flow in either or both directions. Available in standard IPS from ⅛ to ¾ in., valve is claimed adaptable to hydraulic or pneumatic

applications in pressures to 5000 psi. Valves are female threaded to dryseal specifications and available in brass, steel, aluminum, stainless, and special alloys. Dependability, lower friction loss, and greater flow at all temperatures are claimed. Units may be adjusted before, during or after installation. "Straight-through" ball-valve principle serves to permit sensitive adjustments. True-Flo Valve Co., Inc.

19—PVC AIR WASHERS offer economy, minimized maintenance

Of rigid polyvinyl chloride and available in capacities from 1000 to 54,000 cfm, these air washers are claimed to handle acids, alkalies and corrosive fumes more economically and efficiently — cleaning 96 to 99 per cent of contaminants that are instantaneously soluble in water. Due to smooth and non-porous surface of the unplasticized PVC, there is less resistance to air flow, no water absorption and less material build-up on the packing rings or structural surfaces.

In operation, this washer employs a three-way action. 1) Air enters the first section where velocity is decreased and air is sprayed. 2) Air then enters the washer bed where the PVC Raschig rings change air direction at least eight times for thorough cleaning action. 3) Air is fed through the eliminator section where particles of heavily entrained water are removed, leaving the 97 per cent saturated clean air to enter the exhaust fan.

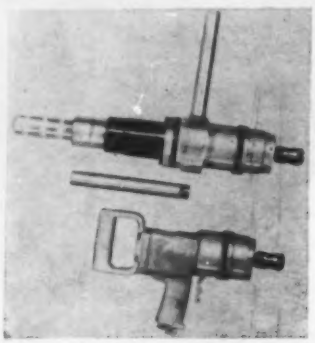
An economy feature of this washer is low water consumption — about 1 gal per 1000 ft of air handled. Additional economy in installation is announced, as these washers weigh about ⅛ as much as steel units of comparable capacity — no additional building supports are necessary for roof installations. Industrial Plastic Fabricators, Inc.

20—INSTANTANEOUS HEATERS with improved steam inlet

Featured in the Ross Type W-100 Instantaneous Heater is an extra-large steam entrance area beyond the tube bundle which prevents tube damage by impingement, according to manufacturer. Standard construction consists of steel shells, cast iron bonnets, and seamless, copper alloy U-tubes. The units are of compact, simplified design with removable pull-through tube bundles. They are available in 128 sizes with two- and four-pass arrangements, nominal tube lengths to 10 ft and shell diameters through 20 in. Complete information is in Bulletin 304.4K1. Industrial Div., American-Standard.

21—TUBE EXPANDER DRIVES are air magnetic units

For fast, precision tube rolling, this air-operated, magnetically controlled tube expander drive comes in two models. In both, rolling action is controlled by a powerful, permanent magnet set to disengage and stop the rolling instantly when preset torque levels are reached.



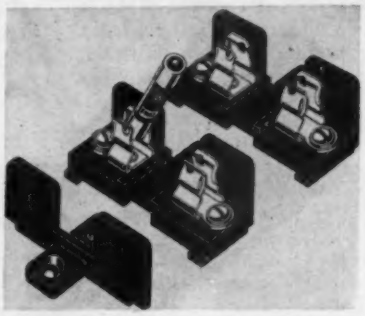
Motors are trigger-controlled, explosion-proof for use in hazardous locations. The complete control is a single, compact unit designed for easy handling by one operator. The motor runs forward when the trigger is squeezed, reverses when trigger is released. No tools are needed for torque setting. The standard model has a motor speed of 1000 rpm, features maximum torque with pistol-type squeeze trigger, weighs 10 lb, and handles most tube expanding jobs. A heavy-duty model, for jobs requiring higher torque, offers choice of rolling speeds, is controlled by valve handle. It weighs 12½ lb. Expanders are available for tubes ¼ through 3 in. in size. Bulletin Y-53 gives details. Elliott Co.

22—CHECK VALVES, steel bodied, spring actuated

These valves are designed to close automatically and silently as soon as fluid flow ceases — eliminating reverse flow. The stainless steel valve disc is center guided above and below to assure a balanced lift, which reduces wear, permits rapid seating. For installation in any position, the valves provide a large flow area, in excess of pipe diameter, which serves to reduce fluid velocity across the seat face and minimize head loss. Two types are available, in sizes from 2 to 12 in., for pressure ratings from 150 to 2500 psi, for all temperature ranges including high temperature hot water heating systems. Specifications on the valves are given in Bulletin 110. Combination Pump Valve Co.

23—FUSE BLOCKS for use on multiple circuit equipment

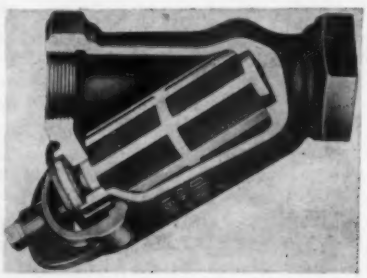
Buss Add-on Fuse Blocks are designed to simplify protection of solenoids or small motors or control apparatus on multiple circuit equipment. They may



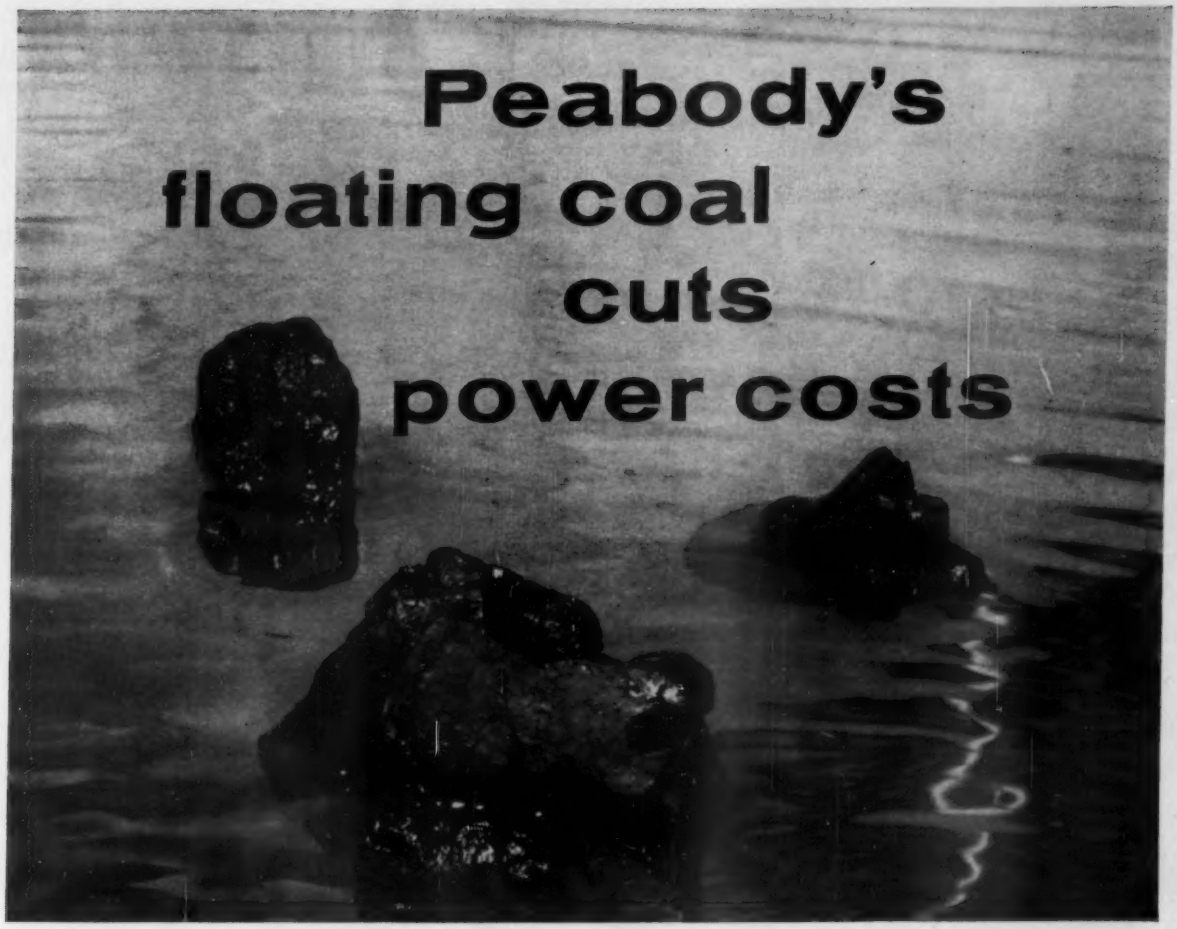
be assembled into a unit fuse block of one or any number of poles. The single pole blocks interlock by means of a boss that slips into a recess in bottom side of the adjacent block. Each unit is locked in place by a single screw. Additions may be made at either end of the assembly, and poles may be added or removed without disconnecting terminal leads on other units. Each fuse can be used as a circuit disconnect. Clips permit raising one end of the fuse to a right angle position to the fuse block where it will be held in place, a feature valuable for quick identification of the open circuit being worked on. Bussmann Mfg. Co.

24—LINE STRAINERS made of lightweight aluminum

These aluminum strainers come in ¾-through 4-in. sizes screwed ends (187-A), and 2½-in. through 4-in., 125 lb ASA flanged ends (187-FA). Standard bronze 14 to 80 mesh woven screens furnished with 100, 200 and 300 mesh screens are available. Stainless steel screens may be



ordered. Used wherever light weight and long life are needed, the strainers weigh only ⅛ as much as many types, it is noted. They cannot rust, says manufacturer and are resistant to corrosive effects



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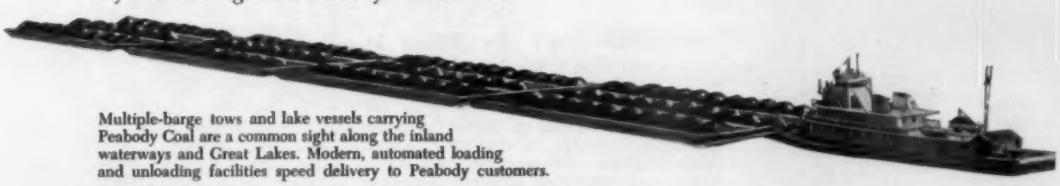

Multiple-barge tows and lake vessels carrying Peabody Coal are a common sight along the inland waterways and Great Lakes. Modern, automated loading and unloading facilities speed delivery to Peabody customers.

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For more data circle 553 on Post Card

of industrial atmospheres. They are suitable for pressures to 75 psi, temperatures to 250 F. Bulletin F-36 gives details. OPW-Jordan.

25—CHECK VALVE, tight closing, for boiler feed lines

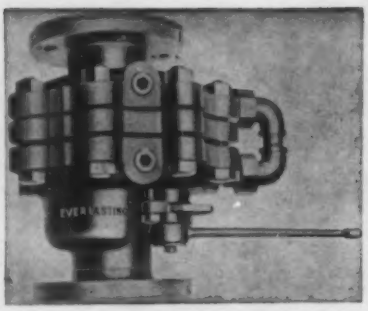
This tilting disk check valve is announced as combining quick, non-slam, tight closing with low pressure loss. It is available in 900-, 1500-, 2500-, and 4500-psi series in 6- to 18-in. sizes. The valve has a one-piece body, permitting an all-

welded piping system. Suitable for horizontal and vertical lines, the valve has integral Stellite seat and Stellited disk face. The seat can be inspected and cleaned without removing the valve body from the line. An "outboard" counterweight attached to the downstream side of the disk serves to assure that the disk swings closed by gravity when hanging free when the valve is horizontal. The counterweight swings out of the flow path when the valve opens Edward Valves, Inc.

26—ALUMINUM COVERING protects insulated elbows

Developed to provide a corrosion resistant aluminum insulation covering, colored Copon Premetco Aluminels can be used for installations where corrosive fumes and sprays could damage untreated aluminum covering, as in refineries and chemical plants. Exterior and interior surfaces are treated by spraying and baking on colored Copon, an epoxy resin. Matching jacketing with

corrosion resistant Copon finish is available for use with colored Copon Aluminels. Tests conducted subjecting Copon from 10 to 400 F are claimed to show no embrittlement or softening of film. Aluminels have a 2-in. overlap beyond turned section. Installation is made with metal holding screws. Screw holes can be punched with an ice pick. Preformed Metal Products Co., Inc.



27—STEAM-JACKETED VALVE keeps viscous materials fluid

Freer flow of viscous materials through valves is claimed with this steam-jacketed valve. It is designed to assure constant temperatures for tar, asphalt, pitch, parafin, waxes, coal tar products, molten sulphur, caustics, resins, varnishes and adhesives, among others, which will not flow at ordinary temperatures. In this model, jacketing has been extended over neck to provide greater fluidity. Offered in two models, one is furnished with an iron body for 125 psig line pressure with 250 psig jacket pressure and a straight operating lever for pipe sizes 1¼ to 4 in. and 6 in. with compound lever, the other model has cast steel body for 150 psig pressure with a 300 psig jacket pressure and a compound operating lever, for 6-in. pipe. Everlasting Valve Co.

28—VERTICAL MOTORS can work outdoors or indoors

Vertical hollow shaft motors in 1 to 30 hp ratings are announced for indoor or unprotected outdoor service on shallow or deep-well turbine pump applications for petroleum product handling, chemical pumping, power plant condenser cooling. Features cited include greater compactness and use of insulating materials designed to provide optimum resistance to moisture and chemical contaminants as well as mechanical strength. Construction is such as to enable fast in-the-field assembly or removal of coupling and thrust bearing with a wrench. For bearing protection the motor has an oil-metering system, sealed bearing chambers and Alnico magnet drain plugs to collect foreign ferrous particles in the oil. Full details on these motors are given in Bulletin 2500. The Louis Allis Co.

29—REFRACTORY for filling in the problem-size voids

Thermastic Super Mastic Cement is introduced for filling voids too large for mortar and too small to "key in" regular castables, plastics or ramming mixes. According to manufacturer, this product's super bonding strength prevents cracking and voids that allow furnace gases to attack outer steel furnace casings. It is claimed resistant to abrasion typical in boilers, incinerators and other heating units. Thermastic Super is described as a wet air-setting, paste-like, trowelable, mastic cement. It adheres to metal surfaces. Company says it remains workable longer than regular mastic cements but dries in half the time. Maximum use is up to 3000 F. J. F. France Refractories.

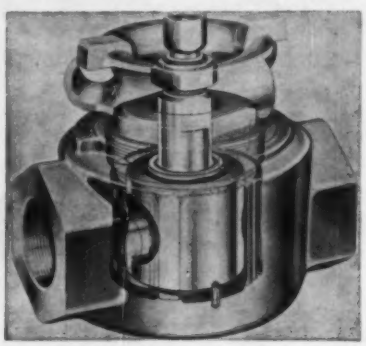
30—INDICATOR LAMPS give light by electroluminescence

For display of luminous letters or numerals in various types of dials and indicators in readout equipment, Rayescent Lamps produce light by electroluminescence. Flat panels of glass with an electrical conductive film are phosphor coated, and when electricity is applied, the panel glows. There are no filaments, tubes or vapors and little heat is produced. Manufacturer says the lamps are fail-proof and the current drain is almost negligible. Rayescent readout lamps are expected to have broad application in indicator panels, status boards, etc. Letters are formed by energizing specific

segments of the 14-segment alpha type lamps or the 10-segment numeric type lamps. Since all segments are on the same plane, the numerals and letters formed are distinct and readable even at wide angle viewing and they require only minimum space. The lamps come in two sizes (the larger is $4\frac{5}{32}$ in. high) and in two voltage designs, 240 and 460 v. They plug into specially designed sockets. Normal rated life of lamps is 3000 hr. Westinghouse Electric Corp.

31—PLUG VALVE is light in weight, strong nnd non-sticking

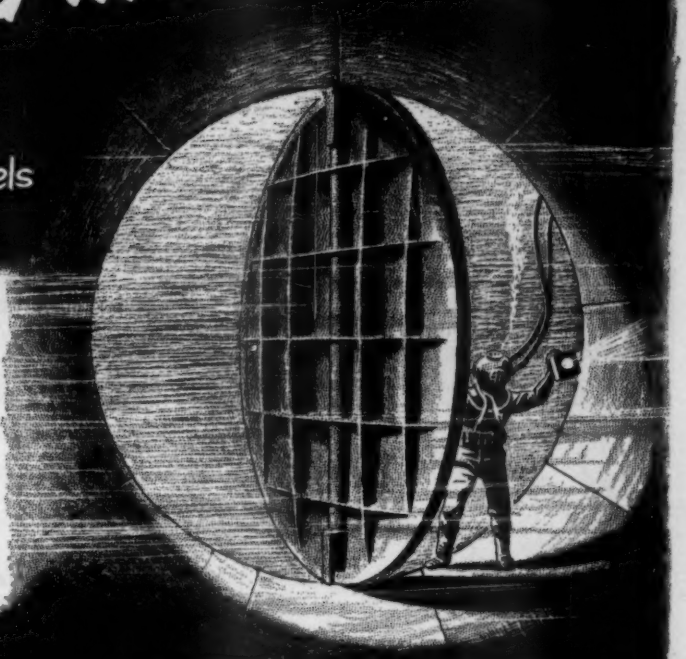
Series D Plug Valve — field tested to 15,000 psi — is stronger and lighter than conventional tapered plug valves, according to manufacturer; also it needs 50 per cent less turning force, can be overhauled in the lines and used in lubricated or non-lubricated service. Company says the valve never needs adjustment and cannot stick because it is not tapered. It has a straight cylindrical seat with segmented design. The plug's corrosion-resistant hard seating surface fits into a set of four metal segments serving as replaceable seats in the valve body. Seats are locked together and



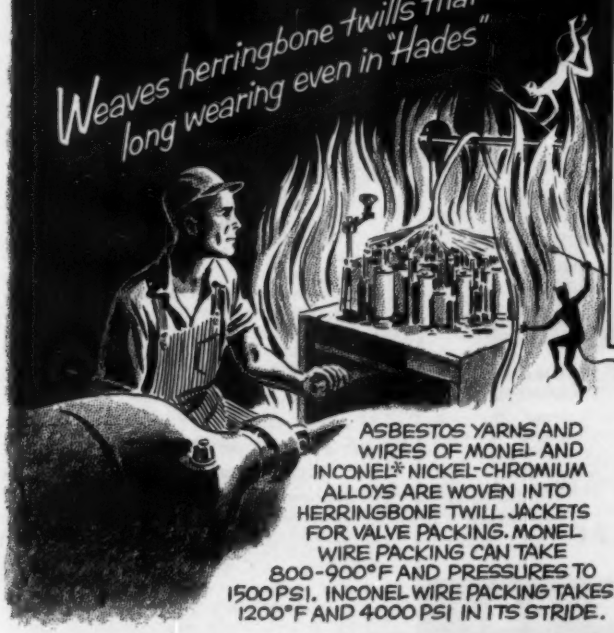
Giant Butterflies repel clams and mussels...

in steam station's cooling water intake tunnels

COLONIES OF MARINE GROWTH COULD EASILY ENCRUST AND CHOKE THE INTAKE OCEAN PIPELINES OF COASTAL STATIONS. ONE STATION NOW DISCOURAGES THESE MARINE SQUATTERS BY AN UNUSUAL REVERSING CONDENSER COOLING WATER SYSTEM THAT WILL SEND HOT DISCHARGE WATER DOWN THE TUNNEL! HEART OF THE SYSTEM ARE FOUR 132" PRATT BUTTERFLY VALVES OF MONEL* NICKEL-COPPER ALLOY. MONEL ALLOY ASSURES PERMANENT, EFFICIENT OPERATION. IT RESISTS CORROSION BY SEA WATER...EROSION BY THE 400,000 G.P.M. OF PACIFIC OCEAN WATER PASSING THROUGH EACH GIANT VALVE.



Weaves herringbone twills that are long wearing even in "Hades"



ASBESTOS YARNS AND WIRES OF MONEL AND INCONEL* NICKEL-CHROMIUM ALLOYS ARE WOVEN INTO HERRINGBONE TWILL JACKETS FOR VALVE PACKING. MONEL WIRE PACKING CAN TAKE 800-900°F AND PRESSURES TO 1500 PSI. INCONEL WIRE PACKING TAKES 1200°F AND 4000 PSI IN ITS STRIDE.

Fingers that can't get burned!

AS THIS QUICK-ON, QUICK-OFF COUPLING GETS HOT, INCONEL "X"* AGE-HARDENABLE NICKEL-CHROMIUM ALLOY "FINGERS" EXPAND TO GRIP HARDER, SEAL TIGHTER AND TIGHTER. THE SUPERIOR SPRING PROPERTIES OF INCONEL "X" ALLOY ASSURE LEAKPROOF OPERATION FROM -320°F TO +1750°F...FROM 0.8 MICRONS VACUUM TO 8000 PSI.

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A TALK WITH ENGINEERS FROM INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU GET BACK ON SCHEDULE. JUST GET IN TOUCH WITH US AND OUTLINE THE DETAILS. AND FOR A USEFUL RUN-DOWN ON MONEL ALLOY, WRITE DEPARTMENT **PE** FOR 30-PAGE INCO BULLETIN, "ENGINEERING PROPERTIES OF MONEL AND 'R' MONEL ALLOYS."

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IMPROVED MODELS

COMPLETE LINE

NEW TYPES

Instantaneous speeds—variations in speeds—average measuring in RPM or FPM—the newest model instruments are described in this new Biddle Bulletin. Handy Selection Chart gives name, range, description and accuracy of all the tachometers in the Biddle line—resonant reed—centrifugal—chronometric—hand and fixed types. Request your copy today.

Check Speeds Accurately

POWER TRANSMISSION
LUBRICATION
SLIPPAGE
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JAGABI® TACHOSCOPE
A Speed Counter and Stop Watch in one

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Speeds Up to 100,000 RPM

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RESONANT REED TACHOMETER
No contact with moving parts—just touch to case of machine or motor housing—read directly in rpm.

METRON TACHOMETER
Activated by flashlight cell. Selection of ranges and scales to 100,000 rpm or 10,000 fpm.

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B-903

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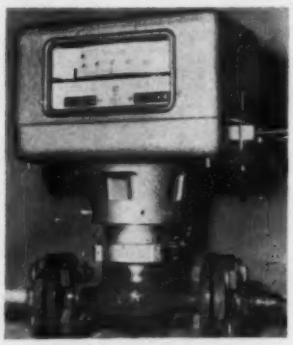
float slightly due to their synthetic elastomer backing. Under pressure, the seal segments rest metal-to-metal against the body. This floating segment design is claimed to prevent plug sticking. Valves come in 1- and 2-in. sizes (⅞- and 1¾-in. openings). Hamer Valves, Inc.

Reader Service Cards on pages 119–120 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

32—HEAT PUMP BTU METER measures heating, cooling

The Pollux Heat Pump Btu Meter is introduced for measuring both heating and cooling consumption in commercial installations and is also adaptable to many kinds of process work. The meter enables charging for both heating and cooling from a central heat pump



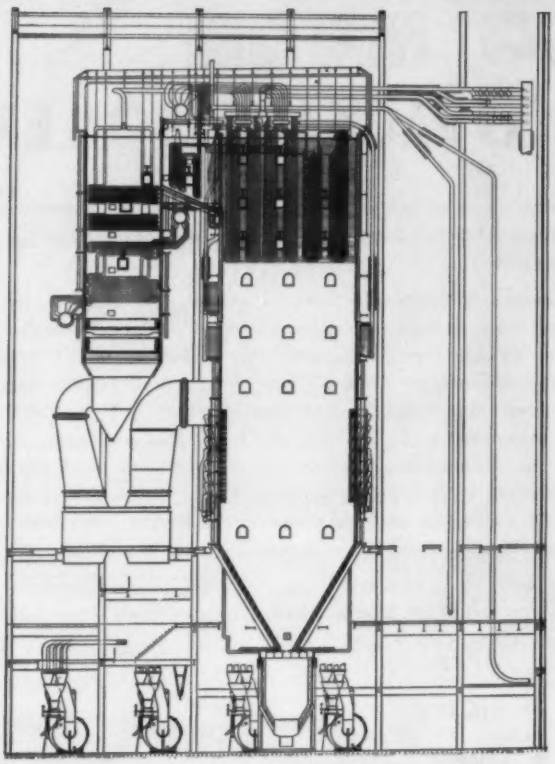
installation through a single meter and in exact proportion to what each area uses. It is designed to measure in Btu's the amount of heat absorption or cooling at the point water enters and leaves an area.

A mechanical device, this meter consists of a liquid meter, an integrator and temperature sensing bulbs in the supply and return lines. The difference in water temperature between supply and return lines is multiplied mechanically by the integrator with the flow of water which has been converted to net weight. The result in Btu's is shown cumulatively on a digital counter. One dial shows heating, a second cooling, depending on cycle in use. Also shown is instantaneous temperature. The meter automatically changes over from heating to cooling. Air Conditioning Equipment Corp.

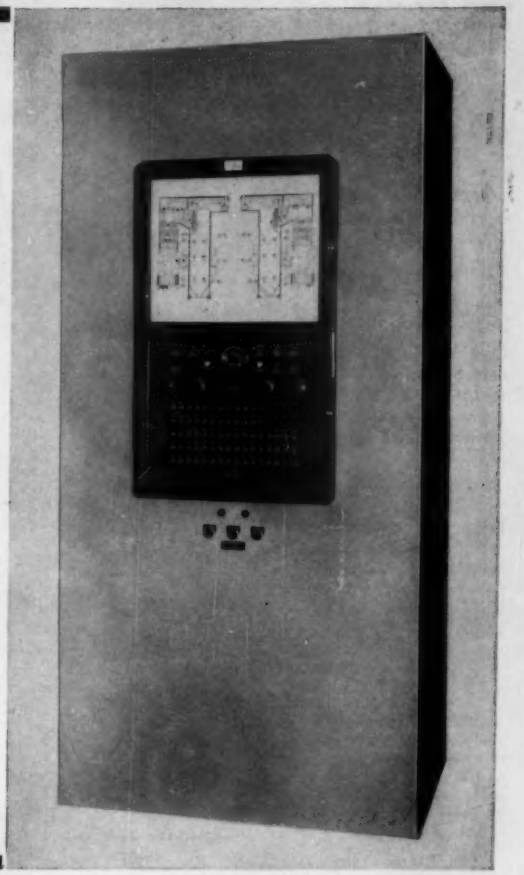
33—TIE WIRE for use in corrosive atmospheres

Copperply is pre-packaged copper-covered steel wire introduced for use with tie wire reels for fastening pipe insulation where salt spray and other corrosives prevail. The 16-gage wire is 15 per cent copper by weight, providing a 1¾ mil copper coating. Copperply is made by continuously electroplating copper concentrically around a steel core wire. It comes in 4-lb coils for use with the Ideal Tie Wire Reel (Ideal Reel Co.). National-Standard Co.

How Copes-Vulcan control systems boost power plant efficiency



Showcase super-critical steam generator will be equipped with a Selective-Sequence System that includes Vulcan T-30 long retractables with 30 to 37-foot travels, half 'tracts with 19-foot travels. Wall deslaggers and air-preheater cleaner controls will also be used.



Nerve center for precision boiler cleaning, the SSC-120 Selective-Sequence Controller is pre-wired and factory assembled for positive control. It handles up to four cycles for each blower. A 60-station model is also available.

Vulcan soot blowing system saves steam, air and manpower

A Vulcan Selective-Sequence System gives the operator the ultimate in finger tip control of *individual* soot blowers. He can set up a sequence to assure thorough boiler cleaning and forget it. He can monitor the program at a glance, stop it, restart it or change any soot blower from any point in the sequence to another to improve cleaning or conserve the blowing medium. Here's complete flexibility without extensive time consuming wiring and piping changes.

Besides Selective-Sequence, Vulcan also builds Automatic-Sequential Systems that can use steam and/or air without a change in equipment, and can provide both simple automatic or manual control.

A complete line . . . a complete service

Over 50 years of design experience backs Copes-Vulcan's broad line of control systems for boiler cleaning, combustion, feed water, pressure reducing and desuperheating.

Whether furnished in individual units or integrated into a single system, each installation gets custom design, skilled continuing service. Trained service men help set up a routine inspection-maintenance program . . . visit each installation periodically.

Bulletin 1029 details Vulcan Automatic Soot Blowing Systems. Write for your copy today.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

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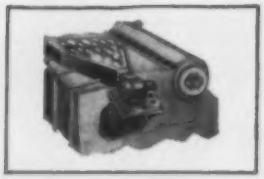
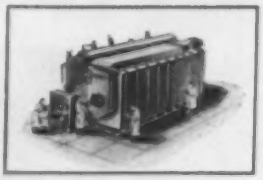
Rear mounted forced draft fan keeps firing front clear and provides proper flow of air to burner register preventing distortion of flame.



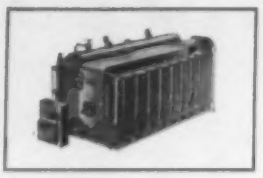
Designed to comply with or exceed Government Specification MIL-B-170958. Either left or righthand units can be supplied.

Capacities to
61,000
lbs. per hour

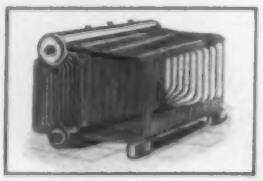
Completely plant assembled and factory fire tested with auxiliary equipment for capacity, efficiency and performance.



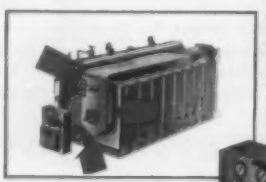
Rotary cup or steam assisted burners. Multiple burners where required. Burners for oil, gas, or both available on all units.



Tangent tube, waterwall furnace, all riser elements, discharge directly to steam drum. Drums extend both ends for maximum volume and releasing area.



Adequate inspection openings in casing. Refractory lined access door. Two manholes in each drum on sizes over 15,000 lbs. per hr.



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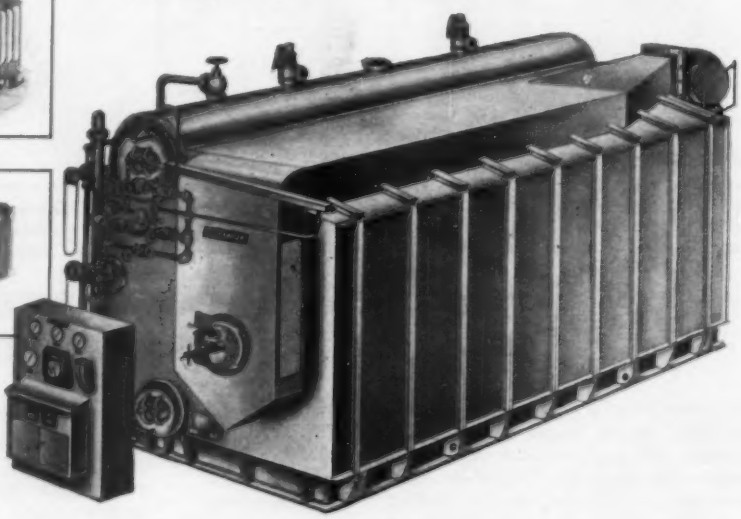
There's no guesswork about Superior Steam Generators. They are designed, built and tested by specialists in packaged boilers exclusively.



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BOILERS, GENERATORS

201 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

202 Boilers for Many Services — This general product data catalog in loose-leaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams it provides tabulated engineering data. Industrial Div., American-Standard.

203 Hot Water Boilers — This 20-pp brochure describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications. Combustion Engineering, Inc.

204 Steam Generators — Catalog 56-1 describes a shop-assembled water tube steam generator ready for immediate installation. Dimensional data tables and diagrams included. The Wickes Boiler Co.

205 Steam Generators — Twelve-pp Bulletin PSG-2 contains design and construction details on company's package unit steam generator — a vertical, bent tube, longitudinally fired water tube boiler. Capacities, dimensions and weights are tabulated and drawings, diagrams and photos showing fabricating methods included. Henry Vogt Machine Co.

206 Self-Contained Boilers — Bulletin AD-162, 8 pp, describes company's complete line of self-contained boilers for heating and processing steam or hot water. Design features and advantages are detailed and a cutaway view showing flow of air in the forced draft system is included. Cleaver-Brooks Co.

207 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr. at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

208 Packaged Steam Generator — This bulletin describes company's type DK packaged water tube steam generator available in units from 6000 to 60,000 lbs. of steam per hour and design pressures from 200 to 600 psi. Gives features, size and capacity of these boilers. E. Keeler Co.

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209 **For Low-Pressure Heating** — Guide Specifications GS-1, 58 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

FUEL BURNING EQUIPMENT

210 **Oil and Gas Burners** — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. The Engineer Co.

211 **Automatic Fuel Burner** — Eight-pp Reference Bulletin 430B describes features and advantages of company's automatic fuel burner. Design and construction details are illustrated and described. Peabody Engineering Corp.

212 **For Burning Refuse Fuel** — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses various components. Riley Stoker Corp.

213 **Oil Burner Parts** — Listed in Bulletin 24 are steam, atomizing, large capacity fuel oil burner parts, including burner parts, detaching gears, and valves for burners. Descriptive details provided. National Airoil Burner Co., Inc.

REFRACTORIES, INSULATION

214 **Refractory Castable** — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

215 **Pipe Insulation** — Featured in brochure J-432 is a lightweight, flexible, one-piece pipe insulation composed of incombustible, moisture-resistant mineral wool fibers, bonded with a phenolic resin and molded into 6-ft long sections. Characteristics of the material are described. Baldwin-Hill Co.

216 **Refractory Mortar** — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

TUBING AND ACCESSORIES

217 **Heat Exchanger Tubing** — Cited in 30-pp Catalog A-205 are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions required it. The International Nickel Co., Inc.

218 **Tube Cleaners** — Bulletin G-515 describes company's line of air, steam

and water driven tube cleaners and accessories. Photos of the various types of cleaners are included, along with descriptive details and specification data. Elliott Co., Roto Plant, Div., Carrier Corp.

219 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

220 Tube Expander Drives — Data on Torq-Air-Matic automatic tube expander drives, including heavy-duty models, is provided in illustrated 6-pp Bulletin 581. A selection chart lists three basic models, for condensers and evaporators, for heat exchangers and for boiler tubes. Thomas C. Wilson, Inc.

COAL AND ASH HANDLING

221 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

222 Water-Cooled Stoker — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

223 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features. American Pulverizer Co.

224 Why Stainless-Clad Steel — Advantages of stainless-clad steel for coal handling equipment are detailed in this 16-pp bulletin. Photo-stories of typical applications in hoppers, chutes, bunker noses, pipes and spreaders are included. Lukens Steel Co.

225 Hydraulic Shakeout — Bulletin 658 describes and illustrates the Carquake, hydraulically powered car shakeout designed for maximum car shaking with minimum noise. Rail- and stationary-mounted types are shown. Six advantages detailed. Stephens-Adamson Mfg. Co.

MECHANICAL POWER TRANSMISSION

226 Steel Conveyor Pulleys — Bulletin A671-A contains 12-pp of information on features and advantages of company's steel conveyor pulleys. Tables and diagrams give essential dimensional data. Dodge Mfg. Co.

227 Forged Steel Couplings — Self-aligning forged steel couplings designed to transmit maximum torque are described in illustrated Bulletin 450-M67. A cutaway

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view shows component features, and tables give ratings, sizes. Koppers Co., Inc.

VALVES, TRAPS, AND PIPING

228 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

229 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

230 Regulating Valves—Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

231 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics covered. Crane Co.

232 Butterfly Valve Manual— Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

233 Water Hammer Control— Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

234 Reducing Valves — Direct-operated water pressure reducing valves are featured in illustrated Bulletin 1009. A cutaway view showing component features is included, as well as water capacity table, dimensional tables and diagrams. Spence Engineering Co., Inc.

235 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

236 Steam Trap — Bulletin 257-B describes a steam trap which uses the kinetic energy of steam to close the valve. Features of trap are detailed, and dimensional data included. Sarco Co., Inc.

237 Ball Float Traps — Eight-pp Bulletin 2891 describes a line of ball float

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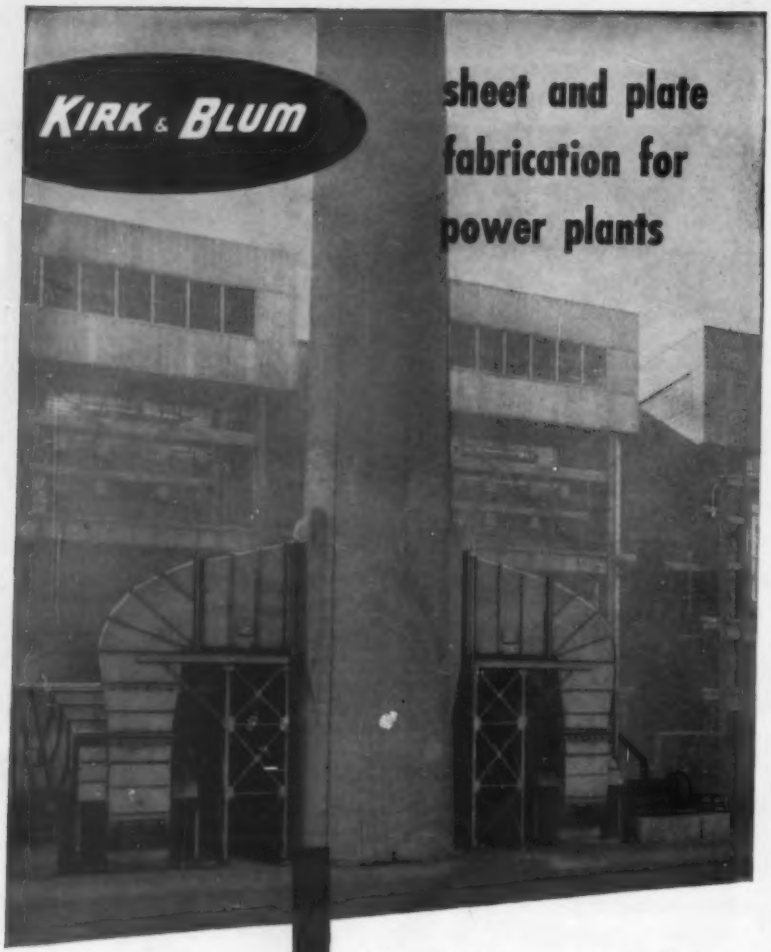

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traps for draining water from air, gas or steam lines, and for draining light liquid from gas under pressure. A section on how to select ball float traps is included. Armstrong Machine Works.

238 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of Type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

239 Insulated Piping—Bulletin 57-1, 24 pp, on prefabricated insulated piping systems, shows typical uses for Hel-cor pipe units for underground or overhead pipe systems. Also describes Utilidor conduits for protection of underground utility services. Ric-wil, Inc.

240 Industrial Expansion Joints — Advantages of company's line of industrial expansion joints designed for rugged temperature and pressure extremes are detailed in this illustrated brochure. Typical applications are pictured. Solar Aircraft Co.

241 Ball Joints — How to solve piping flexibility problems with company's ball joints is explained in illustrated Bulletin 31. Thermal expansion and contraction principle is illustrated. Barco Mfg. Co.

FANS, VENTILATING

242 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

243 Ventilation Units—Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data. Buffalo Forge Co.

PACKINGS

244 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

245 Sheet Packings — Eight-pp illustrated Bulletin P-328 gives detailed specifications, engineering, application and testing data on industrial sheet packings. Nineteen varieties covered are fabricated from asbestos, rubber, Neoprene, silicone, fiber, Teflon, others. Crane Packing Co.

PUMPS AND COMPRESSORS

246 Low Pressure Compressors — Eight-pp Bulletin A-95 describes a line of low pressure compressors for heavy duty industrial applications. Engineering design features are detailed and advantages explained. Joy Mfg. Co.

247 Proportioning Pumps — Catalog 604, 8 pp, covers details and specifica-

tions of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are given. Hills-McCanna Co.

248 For Abusive Pumping Jobs— This Pump Selector covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps. Nagle Pumps.

DUST CONTROL

249 Precipitation Products— Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

250 Dust Control System—Twelve-page Bulletin CJ-1 details advantages of dust control through preventive techniques with company's Chem-Jet system. Describes principle of the system which uses a surface-active compound to prevent dust from becoming airborne. Operation, basic techniques, and installation of the system are covered. Johnson-March Corp.

INSTRUMENTS, CONTROLS

251 Instruments and Controls— Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

252 Gages, Needle Valves— Catalog 76-G consists of a loose-leaf bound collection of literature on gages and needle valves. Various types of gages are illustrated and described, with applications and specifications fully detailed. A section on accessories is included. Jas. P. Marsh Corp.

253 Draft Gages, Instruments— Bulletin 354-B is a condensed catalog giving a briefing on the company's line of stationary and portable draft gages, pitot tubes, air filter gages, gas analyzers, steam calorimeters. Ellison Draft Gage Co., Inc.

254 Bi-Color Gage— Bulletin 2044 describes advantages of the Multi-Port bi-color gage developed to eliminate common gage troubles encountered in low and medium pressure ranges. Design features are illustrated and described and installation methods detailed. Diamond Power Specialty Corp.

255 Resistance Temperature Detectors— In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operations, application and construction details of the resistance temperature detectors are presented. Instrument Div., Thomas A. Edison, Inc.

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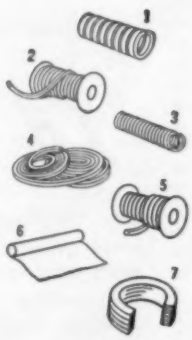

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256 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

257 Controls Data — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated and described. Black, Sivalls & Bryson, Inc.

258 Metering, Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion of pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

259 Guide to Gages—Catalog 300-B, 112 pp, features Ashcroft, Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

260 For Conductivity Measurement — Electrolytic conductivity equipment for the measurement and control of solution concentration is featured in 30-pp Catalog 23. Complete descriptive information and data on various types of instruments for different applications included. Industrial Instruments Inc.

261 Ring Balance Meters — Specification Sheet PM-10002 features a line of ring balance meters designed to convert fluid differential pressure measurements into flow records and indications. Includes description of operation, specifications. Hagan Chemicals & Controls, Inc.

262 Higher Pressure Water Columns — Brochure BO is an introduction to high pressure (251 to 2500 psi) division of catalog data. Describes construction of higher pressure water columns, provides reference list of gages and supplementary equipment. Reliance Gauge Column Co.

LUBRICATION

263 Organized Lubrication — Benefits of organized lubrication are extolled in this 24-pp bulletin. Cost control opportunities are detailed and the task of assigning responsibilities and delegating authority in an organized lubrication system discussed. Method of determining savings and setting up records to measure results is also covered. The Texas Co.

264 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

265 Turbines Lubrication — Basic lubrication requirements for a wide range of turbines and gears are detailed in 28-pp Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units. Oil circuit diagrams and other illustrations are included. Murray Iron Works Co.

WATER CONDITIONING

266 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800 compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use two-bed, three-bed, four-bed, mixed or mono-bed units. Cochrane Corp.

267 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Graver Water Conditioning Co.

268 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization of flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

269 Anti-Foam Agent — A cure for carryover of boiler water due to foaming is described in this illustrated brochure on Concentrol — a surface active agent of the polyalkylene glycol group. Before and after photos illustrate performance characteristics in test case. The Bird-Archer Co.

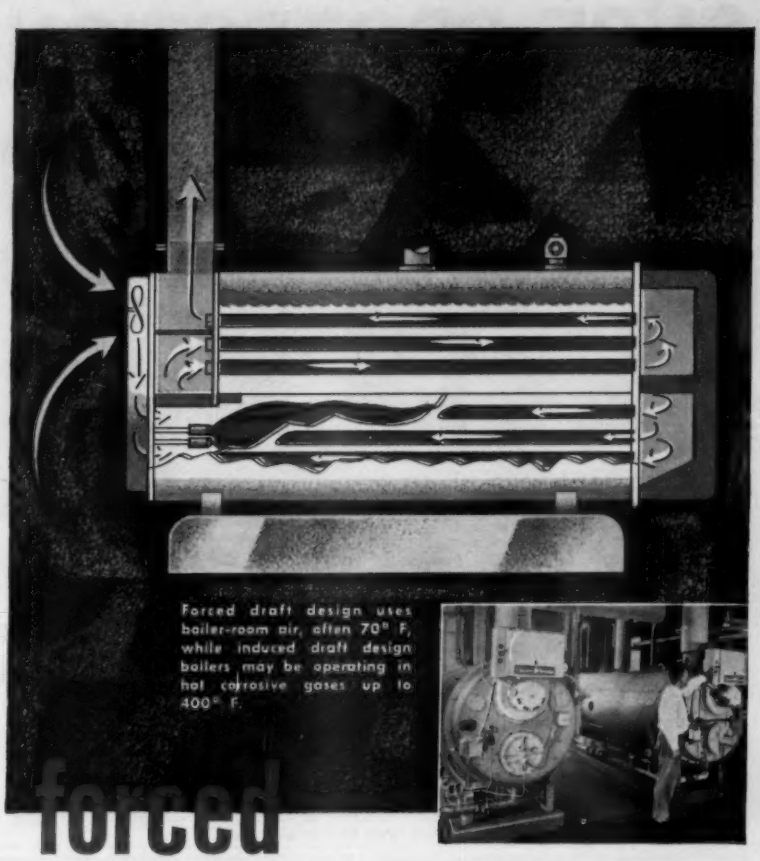
270 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

271 Water Treatment — Described in this bulletin are three protective water treatments available from the company. Gives detailed explanations of potable water treatment, sweet water treatment and others. Western Chemical Co.

272 Products and Services — Bulletin GSP-901 24 pp, describes products and services of this company and its various divisions. These include ring balance instruments, components for control systems, electronic devices, force measuring devices, water and steam treatment, others. Hagan Chemicals & Controls, Inc.

273 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

274 Corrosion Control—Process Bulletin B6 describes company's condensate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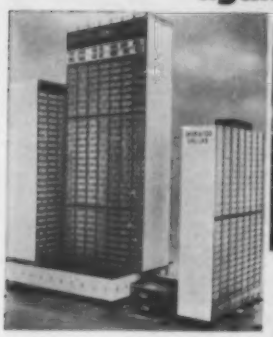

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sate system corrosion inhibitors for protection of return lines, steam turbines, tanks and heaters. Discusses causes of condensate system corrosion and tells how inhibitors overcome these. National Aluminate Corp.

275 pH and Chlorine Control — The 13th, 1957 edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

276 Feedwater Heaters—Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

ELECTRICAL EQUIPMENT

277 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. Book provides wiring diagrams, motor tables. Bussmann Mfg. Co.

278 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos of each type. James G. Biddle Co.

279 Cable Troughs — This 28-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and special devices. The Globe Co.

OTHER EQUIPMENT

280 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

281 Process Equipment — Bulletin G-3B describes equipment for process industries, including pneumatic conveying systems, compressors and vacuum pumps, coolers and preheaters, blowers, gas and vacuum pumps, fans and gas washers, accessories. In addition to describing features and advantages of the equipment, includes engineering data. Fuller Co.

282 Car Dumper — Sixteen-pp illustrated Brochure 957 describes a rotary car dumper capable of handling hopper and

gondola cars and equipped with clamps which hold the dumper car without counterweights. These and other design features are explained and installations pictured. Heyl & Patterson, Inc.

283 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance. Describes rubber and plastic pipe, tubing and fitting; valves; pumps; lined tanks. Amerace Corp, American Hard Rubber Co.

285 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plant installations. Connery Construction Co.

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286 Air Preheater — Featured in this 14-pp booklet is a line of package air preheaters for small boilers and process applications. Fuel savings data is presented, as well as diagrams of typical arrangements, and other details of design and operation. The Air Preheater Corp.

287 Flexible Hose, Bellows — Sixteen-pp Catalog 187 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Flexonics Corp.

288 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

289 Fire Resistant Fluids — Characteristics and advantages of company's fire resistant hydraulic fluids are detailed in this product bulletin. Three types of fluid to suit specific requirements are described. Socony Mobil Oil Co., Inc.

290 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

294 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available. Goodall Rubber Co.

295 Wall Deslagger — Bulletin 1034 features company's wall deslagger designed to minimize average slag thickness for consistently high heat-transfer capacity, and for uniform superheat and reheat temperature control. Photos and cutaway view illustrating design, operation included. Copes-Vulcan Div., Blaw-Knox Co.

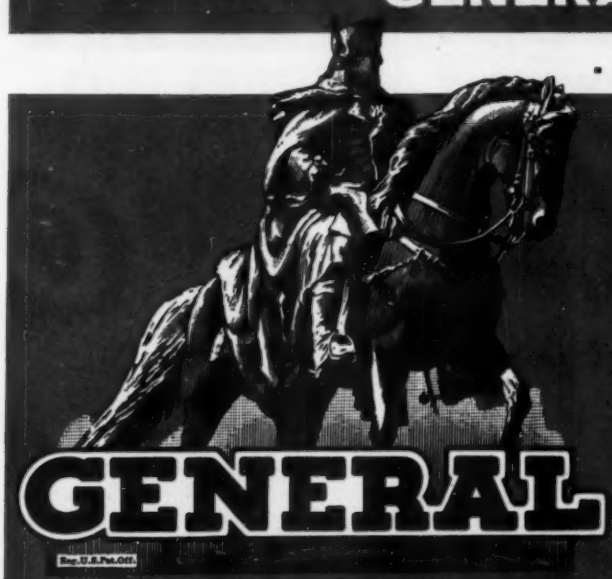
296 Fuel Oil Conditioner — A fuel oil conditioner which dissolves all sludges, prevents new sludge from forming, excels as an emulsifier of condensation, holds water, sludge and oil in complete suspension is described in this pamphlet. Kor Corp, Div. Oxi Corp.

297 Cranes, Hydro Equipment — Twelve-pp Brochure HY-51 describes cranes and equipment for hydroelectric, water supply and other applications. Various components and assemblies that help harness hydroelectric power are pictured, including cranes and hoists, gates and valves, and special hydroelectric equipment. Yuba Consolidated Industries, Inc.

298 Is Salt Just Salt? — This is the title of an 8-pp bulletin describing salt characteristics and properties as well as geographical distribution. Variations in salt from different areas in the United States are illustrated and company's refined products described. Morton Salt Co.

299 No-Frost Refrigeration — Twelve-pp Bulletin 105 describes with diagrams and photos method used for food freezing, chilling and warehouse refrigeration without frost or ice formation. Advantages given. Niagara Blower Co.

GENERAL



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NEW ENGINEERING BOOKS

A Simplified Technique of Control System Engineering, by G. K. Tucker and D. M. Wills. 303 pages, 6 by 9 in. 6 chapters with detailed appendices. Published by Minneapolis-Honeywell Regulator Co, Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa. Price of the book is $5.00.

This book is intended for those interested in process control and in finding out what an analysis of a process control system can tell them, and how it does it. Some experience with industrial instrumentation is assumed to be a part of the reader's background, as well as some knowledge of control of quantities such as temperature, pressure, and flow. No mathematical control theory is required to make use of this most utilitarian work. The practical control system is the subject: how it is designed to work, how to find out about its performance, and how to make it work better.

Dynamic analysis of process control systems can be made with pencil and paper. Anyone who can work with simple formulas and read graphs can understand the basis for dynamic analysis, how the results are obtained, and what they mean in relation to the process control system as the subject is treated with in this volume.

★ ★ ★

Fluid-Power Controls, by John J. Pippenger and Richard M. Koff. 252 pages, 6 by 9 in., 16 chapters. Published by McGraw-Hill Book Co, 327 W. 41st street, New York 36, N. Y. Price $9.00.

A thorough, practical guidebook on valves used for fluid-power control, this volume describes their construction and operation, their proper use in the hydraulic circuit and the most effective methods for maintaining them for best service. The full range of valves is covered, including those used in automated machines. The book also discusses pumps, reservoirs, piping, development of hydraulic circuits, and methods of preventive maintenance and machine repair.

Life expectancy of the components, limitations of service, and best choice of component design are treated in an objective manner. Following modern advances in fluid power, the book explains the growth of 'extreme-dependability' units for the automation of machinery. Among these components are the oil-immersed solenoid, independently drained pilot mechanisms, diaphragm seals, hydraulic fuses, and port seals recently adopted by SAE.

Schematic drawings are blended with cutaway drawings to help the reader understand components both as units for maintenance and as portions of a complete circuit. Joint Industry Conference Standards are given, along with the ASME symbols for fluid-power diagrams. There is a complete glossary of terms for essential communication between designer, purchasing agent, valve and component manufacturer, and the ultimate consumer.

★ ★ ★

The Unfired Pressure Vessel Code Simplified, by Robert Chuse. 48 pages, 8½ by 11 in., paper cover. Published by the author, P O Box 91, Leonia, N. J. Price $6.50.

This valuable book actually greatly simplifies the use of the ASME Code by easy-to-read charts, graphs and diagrams, with good references to the applicable section of the code. It assists in the preparation of welding procedures and welders for qualification. It can save considerable time and material in the design and fabrication of these vessels.

Included are charts for internal and external pressure, shell and head thickness, clear calculations for openings and reinforcements, and other features. These charts are also available separately.

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Gas Turbine Power, by G. M. Dusinberre and J. C. Lester. Second Edition. 334 pages, 6 by 9 in., cloth. Published by International Textbook Company, Scranton 15, Pa. Price $8.00.

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edition is timely and important. With emphasis on the thermodynamic and heat balance aspects of the gas turbine, the book provides the reader with a basic knowledge of the principles of analysis and design, useful both as original exposure and reference material.

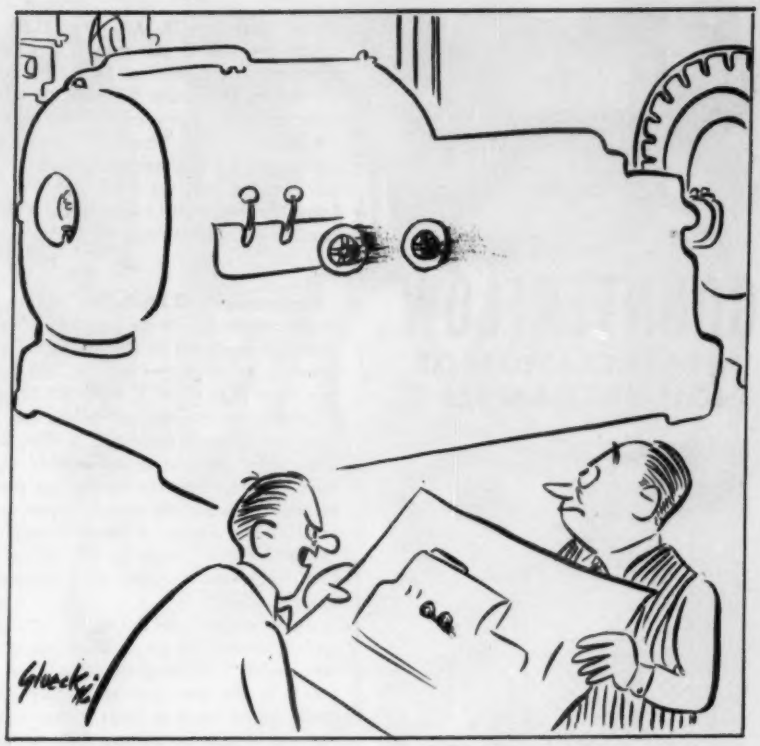
Thoroughly explored is the versatile ability of the gas turbine to fit into and improve almost any heat cycle. Heat transfer considerations in the application of the gas-turbine cycle are discussed, as are the economics of part-load operation. The importance of the prime mover in aeronautics is recognized with considerable material on turboprop and turbojet engines.

New material in the book includes an analysis of the free-piston engine, and use of the gas turbine for automobiles. Application of the closed-cycle turbine with nuclear reactors is also covered. Water injection, blade cooling, variable blade angles, supersonic compression and the comprex are described in some detail.

Book includes typical problems and a comprehensive bibliography. Authors are members of the Mechanical Engineering faculty at The Pennsylvania State University.

★ ★ ★

A Vibration Manual for Engineers, by R. T. McGoldrick. 32 pages. A U. S. Navy publication. May be ordered from Office of Technical Services, Department of Com-



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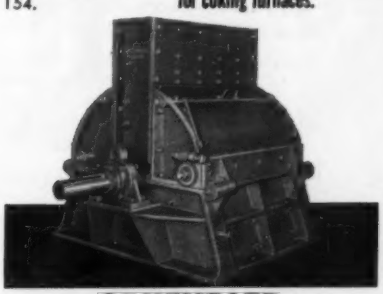

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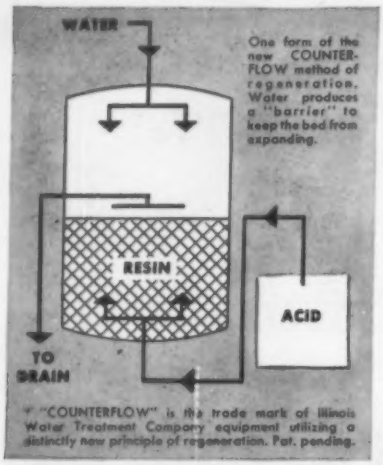
ILLCO-WAY
ionXchange

COUNTERFLOW*

REGENERATION OF ION-EXCHANGERS


WATER
One form of the new COUNTERFLOW method of regeneration. Water produces a "barrier" to keep the bed from expanding.
RESIN
ACID
TO DRAIN

* "COUNTERFLOW" is the trade mark of Illinois Water Treatment Company equipment utilizing a distinctly new principle of regeneration. Pat. pending.

"COUNTERFLOW" is a method whereby upward regeneration, which has long been recognized as most desirable, is successfully accomplished by establishing a "barrier" at the resin face.

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- Distillery in Middle West. TDS in raw water, 575 ppm. Expected cation leakage with conventional equipment, 6 ppm; with COUNTERFLOW, is actually only 1.5 ppm.
- Western power plant, converted to COUNTERFLOW. Savings in acid reduction, $16,000.00 per year. TDS in raw water, 342 ppm. Predicted cation leakage from curves for conventional design equipment, 4 ppm; with COUNTERFLOW, actually only 1.6 ppm.

ILLCO-WAY

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840 Cedar St.
Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

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merce, Washington 25, D. C. Price $1.00.

Main purpose of this manual is to expedite calculations required by the engineer in practice. It contains formulae useful to design engineers in minimizing mechanical vibration difficulties. Most are illustrated by actual cases and thoroughly explained.

Material is based on work done by the Structural Mechanics Division of the Navy's David Taylor Model Basin.

★ ★ ★

Engineering Fluid Mechanics, by Charles Jaeger, translated from the German by P. O. Wolf. 529 pages, 6½ by 9½ in., cloth. Published by St. Martin's Press, Inc. 103 Park Ave, New York 17, N. Y. Price $11.50.

Considering the original publication in 1949, and a French translation in 1954, this first English translation corresponds to a third edition, since the author has made revisions updating the material upon each occasion. It is now one of the most complete and authoritative works on the subject of the design and analysis of water-power schemes.

Author strikes at the theory that hydraulic analysis requires "a special talent, an intuitive feeling," pointing out that developments in the past quarter century have made this as much an exact science as the strength of materials and structures, founded on the laws of fluid mechanics and of hydraulic similarity.

Chapter titles give an excellent summary of the contents of the book: The Physical Basis of Hydraulics; The Basic Hydronamic Equations; The Theory of Flow in Open Channels as a Function of Discharge, Energy and Momentum; Gradually Varied Flow in Open Channels; Rapidly Varied or Discontinuous Flow in Open Channels; Mass Oscillations in Surge Systems; Theory of Water Hammer; Unsteady Flow in Open Channels; Ground-Water Flow; and an Appendix containing a great deal of specialized information and data.

Comprehensive references are found throughout the book.

★ ★ ★

Machinery's Mathematical Tables, Holbrook L. Horton, Editor. 252 pages, 4½ by 7 in., leather-bound. Price $3.75.

This handy book is a collection of the most-commonly used of the tables in Machinery's Handbook. With a modern edge index, it provides ready access to square and cube roots, areas and volumes of plane and solid figures, trigonometric functions, logarithms, all types of conversion factors, and a host of other useful information.

Care should be taken not to confuse this book with The Use of Handbook Tables and Formulas, also based on Machinery's Handbook, which, while similar in size and appearance, is merely instructional material on the use of the Handbook, and does not contain the array of tables presented here. The book should be a great help.

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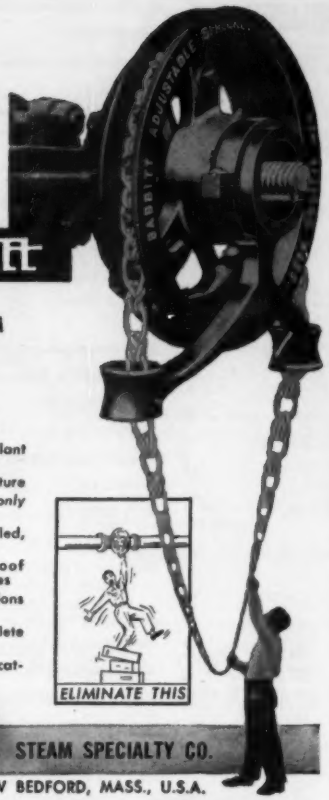

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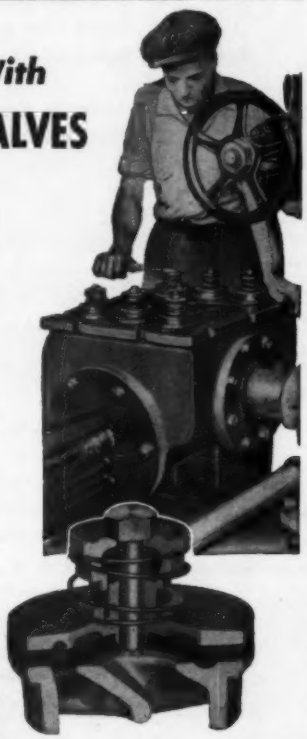

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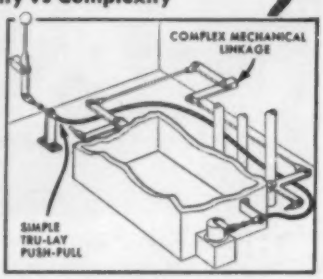
Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



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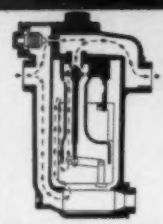
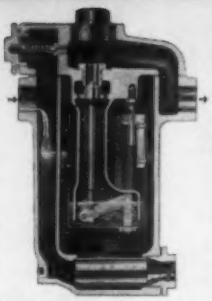


Warm-up speeded by discharge through by-pass as well as main orifice.



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Rapping Frequency... Rapping Intensity... Rapping Pattern
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In the operation of Cottrell Precipitators it is necessary to remove the dust, fume or fly ash that has collected on the plates and cause it to be deposited in a hopper for subsequent removal from the Precipitator. The Rapping System should accomplish this removal with minimum disturbance to the already collected material (to avoid re-entrainment) and with maximum cleaning of the plates.

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There is no "typical" dust—no fixed set of conditions to be met. **Yet the Rapper System must be readily adaptable to efficient dust removal, regardless of dust characteristics!**

Above: Inside view showing unitized circuitry
Left: Unit with dust-tight doors closed

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- **FULL FREQUENCY ADJUSTMENT** from a complete rapping cycle every 50 seconds to one every 3½ hours... or any desired cycle in between!
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A-M-101

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